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A QUESTIONABLE POLICY.

IT is almost a waste of words to remind those of our readers who, for years past, have followed the course of action which we invariably endeavour to carry out, that whenever a grievance is brought to our notice we do not hesitate to express our opinions upon it, and in no measured terms, when we have satisfied ourselves that it requires a little free ventilation, be it either in the case of those we look upon as our friends, or those who have sometimes occasion to regard the REVIEW as a stumbling block to the successful carrying out of schemes which will not bear the fierce light of criticism. There are many who are fain to believe that in consequence of the repeal of the Electric Lighting Act of 1882, electric lighting will have no further obstacles to impede the progress of its immediate development; but those who are better posted, or who all through have had the courage of their honest convictions, know very well that the Act was made the scapegoat for technical shortcomings which were pooh-poohed at the time, and that, as in most industries there are wheels within wheels to be considered, so it is with electric lighting. The subject upon which we are about to offer a few comments is not at present a very serious matter for grave consideration, but, unless nipped in the bud, it may develop into a scandal of considerable magnitude, and this we hope can be avoided. It is well known in artistic circles that Mr. Ruskin appointed himself a censor of art, and, in some instances, for example that of Mr. Whistler, his censorship was of a very tyrannical kind; it appears to us that something of a like nature is on the point of bursting forth in our very midst. We are not sure whether Mr. Ruskin himself is an adept with the brush, but we do know that a certain self-appointed censor of what is right and what is wrong in electric lighting has not had the necessary experience in the business to make his word law. A glimmering of what the subject of our discourse will be is now doubtless apparent, so without more ado we will set about our task.

There is now lying before us a specification (all rights reserved) for wiring a proposed electrical installation in the south-west of London, and it is to this that we desire to draw the attention of our readers.

It commences with a kind of rambling preamble of what is meant by the term wiring, the conditions under which contractors are to tender, the restrictions under which they must labour and the responsibilities with which they will be burdened; with these, however, we do not intend to deal, and we therefore turn to the first question we have set ourselves to examine. This we preface with the information that all materials and work are to be of the very highest character and excellence, the entire installation in each building is to be subject to the approval of Mr. ———, acting for Messrs. ——— and Sons, and he is empowered to reject any work or materials which do not give him satisfaction. Now we come to several important clauses:—"The contractor must keep the entire installation in thorough working order and repair at his own expense for a period of twelve calendar months from its completion, renewal of worn out lamps excepted."

"If, however, from hidden or from any *other causes whatsoever* within the said period of twelve calendar months it be found that the installation or any part of it in any of the buildings is not working efficiently then it shall be in the power of Mr. ——— to refuse to pass such part or the whole of the aforesaid installation until it has been altered and arranged to work efficiently and to his entire satisfaction, and this notwithstanding that the materials, work, and arrangement had previously met with his sanction and approval."

"Payment on account of 80 per cent. of the contract price will be paid within one week of receiving a certificate from Mr. ———, that the whole of the work is complete and to his satisfaction, the balance will be paid at the end of twelve calendar months provided the installation is then in a thoroughly good and efficient condition, free from any defects arising from any bad workmanship, materials, or from *any other cause whatsoever*."

Now let us take as an example of business dealings the relations which exist between a builder, the architect, the firm which owns the edifice about to be erected, and any other contractor who may be employed to do, say, the sanitary engineering work of the establishment. The latter as a rule knows nothing of the owners of the place, and his dealings are therefore with the builder. The architect, as the work goes on, supplies the sanitary engineer with certificates from time to time and, on the strength of these, the builder pays a certain proportion of the contract price pending the completion of the undertaking, when the balance is forthcoming. It will, of course, be understood that certificates are in themselves an admission of the architect's sanction and approval. Now it is, we know, usual for the contractor, if the work is of considerable magnitude and importance, to undertake the responsibility of its efficiency for 12 months, but only in so far as any breakdown can be traced to his bad workmanship, indifferent material, or negligence. Wilful damage or accidents arising from operations carried on by others he is not considered responsible for, nor would it be fair or equitable that he should.

As another instance, let us take the manufacture of a short submarine cable. It is usual for the engineer who is engaged by the owners of the cable to look after their interests to give to the contractors a certificate upon the completion of every 50 knots, when a certain proportion of the contract price is handed over to them, and so on, until completion, when they receive the balance. If the contractors also engage to lay the cable, they then only bind themselves to a thirty days' maintenance.

In matters like the foregoing, as, indeed, in nearly

all contracting work, it is very well understood that the firms who secure the business which is up for tender are not overburdened with such a superfluity of cash that it is a question of indifference to them when payment takes place, and it may be safely assumed that electrical engineers are no better off than others in this important respect. To keep them waiting, then, until a week *after the completion* of their work for 80 per cent. of the money due to them, and then to withhold the remainder for 12 months, when the electric light owners, and contractors, too, for that matter, may have fallen across bad times, is simply monstrous; and we can only point to one or two large companies who could even afford to do it, letting alone the question whether they would attempt to work under such childish restrictions. Still, there may be an object in all this; and if such be the case, we think it will be pretty clearly understood by the initiated in business.

Furthermore, the wiring must be so arranged as to be equally applicable, whether the electric current is generated on the premises or obtained from an outside source, and before the now bewildered and servile contractor can obtain one penny in settlement of his account, he must produce a certificate from the London Electric Supply Corporation stating that the installation is thoroughly efficient and suitable so far as their system is concerned. It might be thought that everything which human ingenuity could contrive to baulk the now demented contractor of what might be considered his just dues, if he had not already renounced all hope of ever getting a cent, had been exhausted; but it is not so. The whole of the work must comply with the Phœnix Office Fire Rules (13th edition), and must be to the satisfaction of Mr. ———, and his approval must be obtained before the drivelling employer of labour is allowed to see the colour of his money.

As if being compelled to submit to such undreamt of indignities as these were not enough, the poor gibbering idiot who was once a contractor, should Messrs. ——— & Sons or their indefatigable representative desire the position of any lights altered during the progress of the work, *must do so without any extra charge provided it does not necessitate any work that has been placed up being done over again.* The italics are our own, but the statement seems to us so extraordinary that we make it prominent. Suppose the work to be nearly completed and the majority of the lamps in place; is the contractor, at the caprice of the Messrs. ——— & Sons, to fix them all in different positions? Such proceedings would not necessarily mean that portions only of the work must be gone over again, but that a good deal of extra and unlooked for labour would be entailed, and for nothing. But the clause to which we now come makes us wonder still more whether the whole thing is serious or only a ponderous joke over which we have wasted much valuable time without hitherto discerning its grim humour.

We well remember Mark Twain's first attempt at editing an agricultural journal, we are familiar with the bland and childlike nature of that "heathen Chinee," and we have not unsuccessfully sought for the half-concealed sarcasm of Carlyle; but all these pale before this attempt to make us doubt our senses. We can keep it in no longer:—"In the event of any dispute or question arising between the contractor and Messrs. ——— & Sons (or their representative) on any matter whatsoever connected with the work or the interpretation or meaning of any part or the whole of this specification at any time during the progress of the work or after the work has been completed, or after the before-mentioned 12 months has (*sic*) expired, then such question or dispute shall be referred to Mr. Musgrave Heaphy to arbitrate upon and decide, and his decision shall be accepted as final and conclusive on both parties."

Now this out-Herods Herod with a vengeance! The idea of the contractor submitting to the arbitration of Mr. Heaphy, whose name we have hitherto kept sacred but which we feel we need not now scruple to divulge, as presumably the inspirer of this quasi-legal specification, takes us back to the days of the "Arabian Nights," when the Genii of the Lamp held his sway and compelled the poor mortals of ordinary mould to yield obedience to his sweet will. But is it not high time that some modern Aladdin should appear and quietly inform Mr. Heaphy that such an unsophisticated nature as that he possesses is altogether out of place in this practical matter-of-fact nineteenth century? The course which he seems now bent upon pursuing "not wisely but too well" will eventually bring upon him a similar fate to that which befell one Humpty Dumpty, and this we should be sorry to see. There is yet another comical side to this. The idea seems to have all along prevailed in Mr. Heaphy's mind that the specification might not be intelligible either in part or wholly to the ordinary beings who make this mundane sphere their habitat *pro tem.*, and this gives rise to the thought that we may shortly require a special kind of expert who might be euphoniously termed the "specification interpreter." Here is a chance for the "sons of gentlemen" who wish to add to their incomes without interfering with their ordinary occupations, and we suggest it in gratitude to Sir John Lubbock or, as he has been dubbed since the introduction of the Bank holiday, St. Lubbock. But, seriously speaking, Mr. Heaphy, considering the varied offices you hold and propose to hold, is it likely that business men are going to submit to tyranny such as this? No! You will yet be taught a lesson in the art of distinguishing between common sense and absurdity, or the result which we foreshadow in our concluding remarks must assuredly follow.

In a conversation with one of the largest gasfitters in the metropolis, we learnt that never in the whole course of his experience has he been subjected to fire insurance inspection, and he is firmly of the opinion that had gas been rigorously confined to the petty restriction which now seems likely to be bound round the electric lighting industry more tightly than ever, it would not at the present moment be holding such a prominent place amongst the essential necessities of the world.

It must not be supposed that we are opponents of the reasonable inspection of electric light installations;

but whilst ever deprecating bad workmanship or materials, inefficient supervision or crass ignorance, and advocating all that is fair and square in electrical engineering, we must not be forgetful that there is such a thing as going too far, and that there is also a limit to human endurance. So sure as we are sitting in our editorial chair, a change will soon come over the spirit of the times, which will bode no good either to Mr. Heaphy or the fire offices under his control.

Electrical engineers will endeavour to get clients to remove their policies to other offices whose representatives, whilst seeing that everything is safe, will accept the risks, if such they can be called, and put no prohibitive restrictions in the contractors' way. One instance of this kind has, we are informed, actually happened.

Mr. Heaphy, with whom we have always been the best of friends, and with whom we shall hope to continue on the same amicable footing, notwithstanding these comments which have been made in no carping spirit and without a shadow of ill feeling, has been too successful with his fire-risk rules. Through a series of blunderings, which should never have taken place, he got the whip hand of the Society of Telegraph-Engineers and Electricians, and he has also gained the confidence of both the electrical profession and the public, the result being that he cannot now rest content with the subject which he has made his own, but must needs seek for pastures new, where he seems to us to be acting the part of the trespasser.

If Mr. Heaphy is in the habit of taking country walks, he has doubtless seen written up in big letters the almost pre-historic legend, "Trespassers beware!" *Verbum sap.*

IN the specification to which we have just drawn attention, we notice that a certain company's lamps of 100 volts and of 16 or 8 C.P. must be used. Now is this consistent with the terms of that paragraph which tells us that all materials must be of the very highest character and excellence? There are lamps which bear a higher character and the use of which would effect a considerable saving of copper, as we see with surprise that no main or principal branch wire is to carry more current than in the proportion of 500 ampères to the square inch, nor any smaller branch more than 750 ampères for a similar section. It is always well to be on the safe side, but the factor of safety allowed in this case is altogether unnecessary. So far as testing is concerned it is essential that the insulation resistance should be extremely high, especially with regard to *earth*. We would suggest that the *ground* work of the whole installation should be placed on a sheet of unpolished ebonite.

WITHIN a few hours of penning the above remarks respecting the character of the above mentioned lamps, we have been furnished with further proofs of our assertion that better and more economical lamps are obtainable. In the Exeter Asylum it has been found that 100 Woodhouse & Rawson lamps could be run from a given accumulator charge at their normal candle-power for 14 hours, whereas after they had been displaced, through an injunction, by those manufactured by the other company, it was found that they could only depend upon the lighting for nine hours. Further particulars respecting this important point may be seen on page 160.

AT the meeting of the Direct United States Cable Company, Limited, reported in our issue of the 27th ult., Sir John Pender, K.C.M.G., chairman of the company, alluded to the "terrible calamity" which had befallen their general manager and we are sorry to learn that he is not likely to recover. Can it be possible that "genial John" as his friends in the submarine telegraph world delighted to call him, is doomed to end his days bereft of reason? When the question arose of finding a successor to poor Fuller, Sir John pleaded the inability of the company through poverty to support one, and that therefore "for all practical purposes he himself might be regarded as the general manager." At the conclusion of this statement several shareholders present thought a general manager should be appointed on account of the numerous engagements of the chairman and contended that it was not right for him to endanger his own health and their interests by undertaking further duties as general manager of the company. "Sir John was a director of 16 companies, of seven or eight of which he was chairman." Since then we see that Sir John has become the chairman of a new company which promises to supply electric light on a large scale. We are anxious, for several reasons, to know what will be said at the next meeting of the Direct Cable Company. At the meeting to which we have already referred, we thought that the chairman went out of his usual course to explain why the work of repairing their cable had been given to the Telegraph Construction and Maintenance Company, but we now think we begin to understand the reason, for since that meeting we have received the prospectus of the new electric light company, and we notice that Sir John is to be chairman, while the managing director and one of the directors of the Telegraph Construction and Maintenance Company are to be his lieutenants in this new undertaking.

THE Metropolitan Electric Supply Company, Limited, on the prospectus of which we commented last week, has been the subject of considerable criticism, and, with an exception which can readily be understood—namely, that of the *Financial News*—the criticisms are tolerably unanimous on all important points. The issue of founders' shares is much discussed and generally condemned, and with the condemnation we quite agree. We did not notice the subject very pointedly in our last issue for the reason that we do not consider that the objectionable shares can for a long time reap the plentiful harvest it is intended they should; indeed, we think it will be difficult enough to make the 7 per cent. on the ordinary stock of the company, but there can be no doubt that unless the said 7 per cent. is cumulative, the directorate may be exposed to great temptations and probably to an annoying amount of suspicion. The letters of allotment and regret (should not this read allotment and congratulation) of this company have been sent out, and it is said that a flood of subsidiary companies is to be started. Seeing that the company holds no patents and represents no particular system we are tempted to ask, why?

THOSE of our readers who are interested in the galvanic belt and generator quackery have a treat in store next week. Several subscribers have taken the trouble, not uselessly, as we shall show, to send us copies of notices issued by the Magneto Electric Battery Company, which direct attention to a truly marvellous

"scientific discovery," yclept, Dr. Lowder's magneto electric battery. We are assured that by its application strength and vitality is (*sic*) given to the nerve force, that it acts directly on the circulating system, and that being in harmony with the magnetic laws of the body it sustains the various functions. It is claimed to effectually cure most complaints, and hundreds of little nerves and muscles are said to respond to its action directly it is applied. Last week we politely requested in writing a specimen of the battery for testing, and, to our surprise no less than gratification, a representative of the company obligingly brought one to this office. Unfortunately, we were not in at the time, but we are informed by the gentlemen left in charge that a consideration would be offered us if we would consent to allow our names to appear in support of the pretentions of the company, which it is proposed to largely extend. This we must reluctantly refrain from doing, as we shall later on require all our energy and vitality to express our feelings. The battery in our hands will certainly act on the circulating system, for wherever the REVIEW circulates there will be seen the results of an investigation on an article before which the electropathic belt previously described by us almost pales. The harmony which until recently had existed in the magnetic laws of our body has been seriously disturbed, and we fear that nothing will prevent a further series of discords between ourselves and the vendors of bogus electro-medical appliances, for the hundreds of little nerves and muscles in our editorial anatomy are contracting furiously, although we have not even applied the cell ("star side to be worn next skin") to our manly chest.

MR. PECK, to whom we refer in our "Notes," gives a description of the method adopted by the Thomson-Houston Company for the protection of the public from shocks when employing high-tension currents and transformers, and he claims that there is no possibility of the high potential affecting persons through accidental contact with the secondary wires, even should there be connection between the primary and secondary windings of the transformer. "In the first place," says Mr. Peck, "the company operates its dynamos at a potential of but 1,000 volts, as against 1,800 to 2,500 used, and so far with safety, for the past two years or more in many places abroad. For every installation of transformers a lightning arrestor is used which is absolute in its action, and effectually prevents any ill effects to the transformer, from a lightning stroke upon the line when properly installed. Then the primary winding is separated from the secondary, by a very substantial septum of insulating material, thoroughly dried and shellaced; and finally, the secondary, or interior circuit, is soundly connected to the earth. Where is there any danger now? Even if the high potential were to get upon the secondary line, what possible harm could be done? Suppose the primary line in a first class condition, and the secondary properly grounded as described; also the accidental contact between the primary and secondary. A person touching the secondary, and at the same time making contact with earth, would be affected in what manner? Not at all. Why? Because there is no complete circuit. But go further and suppose a ground upon the primary as well. A person touches the secondary, and again there is no effect. Why? Because there is a complete shunt about his body caused by the earth and the ground connection, and even if the transformer were not instantly cut out of the circuit by the fuses melting, all the current would go by a shunt which is of no resistance, and would not influence the man at all."

A FEW weeks ago a Reading clergyman described the experience of a man in his employ who received an electric shock during a rain storm, but which was not attended by thunder or visible lightning. Several other similar cases have been since described. First, there is an account in the *British Medical Journal* by Drs. Cook and Boulting of the injuries received by two sawyers on the Spaniards farm at Hampstead. The man most injured, the elder of the two, was leaning against an oak tree. There was no rain nor any sign of a thunderstorm. The other was sitting on a block of wood 3 feet away, and two saws, 6½ feet long, were leaning against the fence about 2 feet from the trunk of the tree. The first man saw nothing and felt nothing; he was struck senseless instantaneously. The second heard a deafening thunder clap and felt stunned for some minutes, but had no sensation of pain. Then he discovered that his clothes were smoking and burning, although not ablaze. He then saw his companion lying senseless on the ground, quite still, as if dead, and his clothes partially torn from him. Having put out the fire in his clothes he crawled (he could not walk) to the road near and shouted for assistance, which soon arrived, and both men were conveyed to the infirmary, where, upon being roused, the elder man regained consciousness to a slight extent. Burns were found on the right side from the shoulder to the feet. The legs of the other man also had marks as of burns; both were in a state of collapse. After 11 days in the one case and 14 in the other the men recovered. The doctors remark that it should not be forgotten that dangerous return discharges from the earth to the atmosphere may take place at a considerable distance from an atmospheric storm.

ANOTHER case, this time a fatal one, of a lightning stroke without the visible appearance of lightning comes from France. At Puy-de-Forche, in the Department of the Dordogne, during a thunderstorm, a girl was seen to walk towards a tree and clasp it. No lightning was seen, but in a moment the girl fell backwards, and when examined was found to be quite dead, with appearances which indicated that she had been killed by an electric stroke.

A SECOND fatal case is related to have taken place in the Island of Fariguana. During a rainstorm a lineman observed that a lightning rod was fused at a point in contact with the building to which it was attached. He tapped the ground end of the rod with a hammer and immediately fell dead. The hammer had two metal strips reaching from the head down the handle. It is suggested that as the building stood on a rock and the lightning rod was grounded in a deep well, there may have been considerable difference of potential between the place where the man was standing and the grounded lightning rod. This case again goes to show that lightning rods should not be insulated from the buildings to which they are attached. All these instances prove one thing clearly, and that is that the danger from lightning is even of more subtle character than is generally supposed, for it may strike down its victims without warning or manifestation.

MANGANESE STEEL.

SOME experiments which were carried out by Dr. John Hopkinson, F.R.S., in 1885, and which formed the subject of a paper read by him before the Royal Society on "Magnetisation of Iron," caused a large amount of attention to be drawn to that peculiar form of steel known as "manganese steel." Dr. Hopkinson found that in a substance with a substantial proportion of manganese, the latter "annihilates the magnetic property of iron," and that steel containing 12 per cent. of manganese is practically *non-magnetic*.

Naturally it occurs to one what bearing would this non-magnetic property of iron have in the manufacture of dynamos.

Some information of a very valuable character as to the non-magnetic and electric properties of manganese steel has been contributed lately by Mr. R. A. Hadfield in a paper read by him before the Institution of Civil Engineers on "Some Newly discovered Properties of Iron and Manganese." It would appear that the non-magnetic properties of manganese were noticed as far back as 1774, when Rinman seems to have been the first to observe the curious fact that manganese deprives iron of its usual magnetic properties. He found that after melting equal parts of grey pig iron and manganese ore, the lump or button produced was, when fractured, of a white colour, very brittle, and the magnet produced no action thereon. This peculiarity was also noticed in David Mushet's early experiments in 1830 on manganese. Mr. Hadfield remarks that this is especially curious, seeing that iron is present in amounts eight or nine times greater than the manganese itself. "An approximate idea of the amount of manganese contained in the steel may be formed by passing a magnet over specimens; as the percentage of manganese increases the magnet's power decreases. Upon reaching about 8 per cent. there is no attraction in the bulk, though fine drillings are influenced; but even this diminishes, as when 20 per cent. is reached a magnet capable of lifting 30 lbs. of ordinary steel or iron will only lift pieces weighing a few milligrammes. On this point the material behaves in the same manner either in its forged or cast state; water, or oil-quenching, making practically no difference.

Since Mushet's experiments nothing appears to have been elicited of a definite character until 1885, when some facts were brought out by Dr. John Hopkinson, F.R.S., in some experiments carried out by him, which are given in the paper previously mentioned. Amongst the samples tested were some of manganese steel manufactured by Messrs. Hadfield, and of their behaviour under the influence of magnetism we have the first definite records. Dr. Hopkinson says: "Another very striking feature is the way in which any substantial proportion of manganese annihilates the magnetic property of iron; the sample with 12 per cent. of manganese is practically non-magnetic. If all the substances in this sample other than the iron were mechanically mixed with the iron, and arranged in such wise as to have the greatest effect upon its magnetic property, no such annihilation of magnetic property would ensue." He states that "it is therefore clear that the small quantity of manganese present enters into that which must be regarded for magnetic purposes as the molecules of iron, and completely changes its properties. The fact is one which must have great significance in any theory as to what is the molecular nature of magnetisation." The sample of iron with 12 per cent. of manganese and some small quantities of carbon and other substances is proved by these experiments to be slightly magnetic, that its magnetism would be accounted for by supposing that in its mass were distributed a few little bits of pure iron.

Some more specific details as to the non-magnetic character of manganese and its electrical properties will be found in a paper "On the Physical Properties of Manganese Steel," published in the "Scientific Proceedings of the Royal Dublin Society," 1886, by Professor W. F. Barrett, of the Royal College of Science, Dublin. These details are from experiments carried out by Professor Barrett on a sample of Hadfield's manganese steel (C. 0·85 per cent., Mn. 13·75 per cent.) drawn into a wire of No. 19 B.W.G. A very great deal of difficulty was experienced in the process of drawing the wire down owing to its hardness, but it was found that by heating the rods to a white heat and plunging them into cold water, they were easily drawn; but the same process had to be repeated after every reduction to two sizes. The remarkable tensile strength of this wire was determined by Professor Barrett at 110 tons per square inch. As regards the non-magnetic properties of this steel, Professor Barrett found that a small piece of the wire tested by him was not attracted in the slightest degree by the most powerful electro-magnet capable of lifting *a ton*, but suspended by a thread it behaved like a para-magnetic body pointing from pole to pole. In a sample which gave a faint trace of magnetism, Professor Barrett was enabled to make a determination to the extent that taking the magnetism of ordinary iron as 100,000, the manganese steel was 20. It was suggested by Mr. Hadfield that this peculiar non-magnetic quality of manganese steel might make it suitable for dynamo bed-plates. We are not aware that any definite experiments have as yet been tried by others on this interesting point, but we hope shortly to place before our readers some results of experiments which are being tried at our suggestion.

A second point with regard to the electrical properties of this manganese steel, and one which must prove of great interest to electricians and especially to electric light engineers, is the remarkable results obtained as to conductivity. Professor Barrett found that its conductivity was very low, No. 19 B.W.G. wire 0·96 millimetre in diameter, having a resistance of 1·112 legal ohms per metre, or 75 microhms per cubic centimetre at 15° C. Ordinary iron wire being only 9,800 and German silver 21,170, he suggested that use might be made of manganese steel for resistance coils in electric lighting. This suggested use was successfully applied by Dr. E. Hopkinson at Messrs. Mather and Platt's, when some experiments were tried (described at the time in these columns) to demonstrate Dr. John Hopkinson's method of testing the efficiency of dynamos. A length of 1,180 yards of 8 B.W.G. (Mn. 13·95 per cent.) was cut into three lengths, coupled parallel, the conductor consisting of 3 strands No. 8, then coiled into a box 3 feet by 2 feet by 2 feet, gave a resistance of 6·5 ohms, carrying 80 ampères without overheating. It was therefore capable of absorbing 55 H.P. Mr. Hadfield remarks on this that "to produce the same resistance with iron wire 5,000 to 8,000 yards would be required, or of expensive German silver wire 4,780 yards." The increase of temperature, when heated, Prof. Barrett found to be only 0·136 per cent. for each degree C. as against iron 0·5 per cent. It will be seen therefore of what value this material may become where resistance coils are required for electric lighting purposes, as it appears to possess the necessary qualifications in a higher degree than any other metal.

The results as regards resistance have been verified in some tests taken by Mr. Mordey, who remarked, in the discussion which followed the reading of the papers read by Mr. Hadfield, "It would be observed that the manganese steel, besides being non-magnetic, had a very high resistance; and as it had great strength, it would probably be used for purposes other than those contemplated in the paper. Electricians wanted a metal or an alloy that could take the place of German silver for light castings in the fittings of machines and apparatus where alternate currents were to be used. In alternate current dynamos, for instance, the small castings for the ends of the coils, and other portions which passed through the field or into the fringe of the field, were almost always of German silver." If Hadfield steel could be substituted, Mr. Mordey thought it would give just what was wanted, as castings for this purpose should have great strength combined with lightness; they should have a high specific resistance to prevent loss by eddy currents; and, generally, they were better if non-magnetic. In this direction we think that there

is decidedly an opening for the employment of this material, but there are at present apparently some difficulties required to be overcome in consequence of the hardness of the steel.

With regard to this material and its combination, we find that Dr. Hopkinson considers that the manganese was not merely mixed mechanically with the iron, but that it did enter into the molecule in such a way as to destroy its magnetic properties. He remarks that "the magnetic property was really that which was most interesting, for it distinctly and clearly demonstrated that the material was not a mechanical mixture, but something in the nature of a chemical compound." There are many of our readers who are not aware of these peculiar properties of this alloy, and we have been induced to place these observations before them, in the hope that some amongst them may be enabled to carry out some further experiments, which may conduce to the further development of manganese steel and its possible successful adoption, for not only the purposes which we have mentioned but possibly for others also of still further utility to electrical engineering.

THE INFLUENCE OF THE CONDENSER ON DISRUPTIVE DISCHARGES.*

By E. G. ACHESON.

WHILE investigating some troubles in an arc light circuit recently, I was led into a series of experiments on the subject forming the title of this communication, and while the method of experimentation was rather crude, the results obtained are, I think, of a value sufficient to warrant my presenting them to the public.

For the experiments a direct current of an E.M.F. suitable for the work was not at hand, so an alternating one was used, connections being made to the street mains of an electric light plant, the E.M.F. on the circuit being 1,000 volts.

A special transformer was used, having five terminals, the primary forming a portion of the secondary circuit.

One of the terminals was connected direct to one side of the experimental working circuit, while by means of a switch, either one of the other four could, at will, be connected to the other side of the circuit. By this arrangement four E.M.Fs. could be had, as desired; and for convenience of expression, I will term these different connections, circuits, and number them 1, 2, 3, 4, in the order of their E.M.Fs.

In order to determine the E.M.Fs. of these circuits, I made a series of 50 measurements of each, using Law's method for direct currents. The condenser was made of a plate of glass with tinfoil on each side, and was found to have a capacity of ·00282 microfarad, and answered admirably for the work.

The condenser being placed in the circuit would, upon opening the circuit, by means of a key, hold a charge of a value dependent upon the potential of the terminals of the transformer at the moment of opening, and by suitable connections this charge could be discharged through a galvanometer, and its exact value determined.

This operation of charging from the transformer and discharging through a 10,000 ohm mirror galvanometer, was repeated 50 times for each of the four circuits. Of the 50 determinations of the E.M.F. for each circuit, the highest value obtained was assumed to be the true one for its circuit.

By this method I found the four circuits to have the following E.M.Fs.

Circuit No.	1	...	...	...	580 volts.
„ „	2	...	...	...	1,110 „
„ „	3	...	...	...	1,690 „
„ „	4	...	...	...	2,114 „

The transformer was built for 2,000 volts with 1,000 volts in the primary circuit. My results showed a little over that amount.

Having now the data necessary for plotting the E.M.Fs. of the circuit, work was directed to the measuring of the spark lengths, and the investigation of the influence of the E.M.F. and condenser on them.

Three condensers were made as before described, and carefully measured. The capacities were:

Condenser No.	1	...	...	·0018 microfarad.
„ „	2	...	...	·00219 „
„ „	3	...	...	·00282 „

The working circuits without a condenser were found to have a capacity of ·0004 microfarad, and when working up the measurement, this capacity was always added to that of the condenser used.

To measure the spark lengths, an arrangement of apparatus was used, as shown in fig. 1, in which

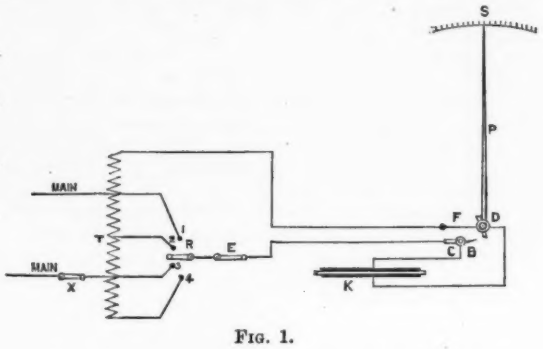

FIG. 1.

A and B are two points mounted in the posts, C and D, the latter being made so as to to turn upon its centre; P is a pointer attached to D; S is a scale; T is the transformer; R is a switch for connecting up either one of the four circuits; E is a switch used for opening and closing the experimental circuit; F is a fusible wire connection, to protect the transformer; K is a condenser, and X a switch for opening main line.

The relative distances from D to S and A, were as 15 to 1, and the scale was graduated so that a movement of the pointer one division, moved the point, A, one one-hundredth of an inch, but owing to the size of the graduation, a movement of one one-thousandth of an inch could readily be detected.

The mode of operation was to first set the points so as to just touch each other, and the reading of the scale noted, after which D was swung upon its centre, sufficient to draw A from B such a distance as to prevent a discharge occurring across the intervening space, upon opening and closing E 50 times. A was then caused to approach B by steps of one one-thousandth of an inch; 50 ruptures of the circuit being made after each advance.

When a discharge occurred, note was made of the scale reading, and the difference between it and the first reading was a measure of the spark length. The true distance between the points would, of course, be the chord of the arc described by the point, A; but the distances were so small that this error was neglected, and the distance measured on the arc. When a condenser was used, it was connected up between the posts C and D, as shown in the figure.

Measurements were made with this apparatus of the spark lengths produced by each circuit, first without a condenser, and then with each of the three condensers, successively connected up to C and D. The results obtained for the various conditions were:

	Spark lengths in inches.			
Circuit.	1	2	3	4
Condenser No. 0	·008	·0085	·018	·025
Condenser No. 1	·002	·018	·062	·145
Condenser No. 2	·004	·027	·080	·177
Condenser No. 3	·005	·037	·103	·211

* *American Exchanges.*

Fig. 2 shows the results obtained in curves; each curve being numbered the same as the condenser used to produce it; No. 0 being the curve determined without a condenser.

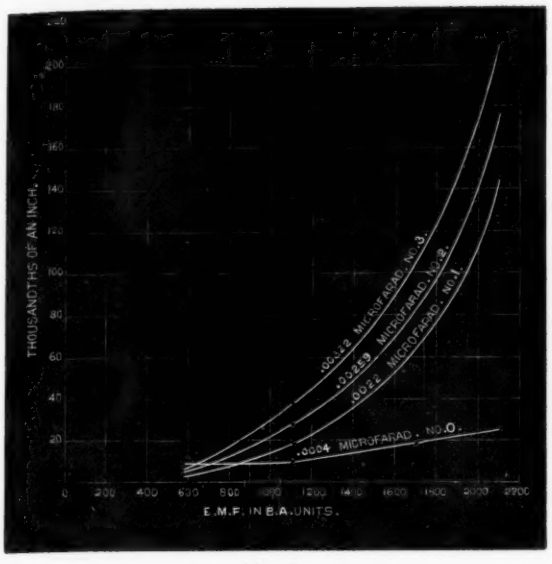

FIG. 2.

In fig. 3 I have plotted the curves by laying off the capacity of the circuit horizontally, and, as before, representing the length of the spark by the ordinates.

The four curves represent the four circuits, and are numbered accordingly.

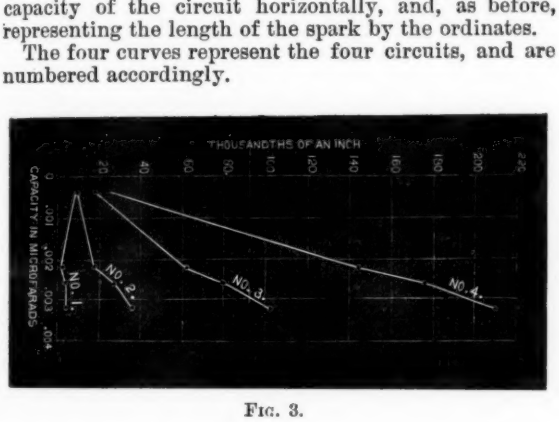

FIG. 3.

To determine whether the E.M.Fs. were influenced by a discharge from the magnetic field of the transformer, they were remeasured with a condenser having a capacity of ·00077 microfarad. If a discharge occurred, the increase of the E.M.F. above the true value would be proportional to the discharge, and the latter would be subject to the amount of current on the circuit; hence, by decreasing the capacity of the condenser, a lower E.M.F. would result.

The E.M.Fs., as measured, were: Circuit No. 1, 625 volts; circuit No. 2, 1,176 volts; circuit No. 3, 1,580 volts; circuit No. 4. 2,058 volts.

The E.M.Fs. of the first and second circuits are higher, and those of the third and fourth are lower than those obtained with the larger condenser, but the differences are not greater than would be expected under the circumstances, and, as will be seen from the curves produced, their relations are such as to leave no ground for assuming a discharge from the field.

I would mention that while the first set of E.M.Fs. were determined when the machinery in the laboratory and surrounding neighbourhood was in motion, the second set was measured under the most favourable conditions, the machinery being motionless.

In fig. 4 I have plotted two curves, A and B, in each of which the ordinates represent the length of the spark, and the abscissæ the E.M.F. in B.A. units.

The experimentally determined spark lengths for each of the four circuits are the same in both curves, and are marked with circles.

Curve A was plotted from the E.M.Fs., as found with

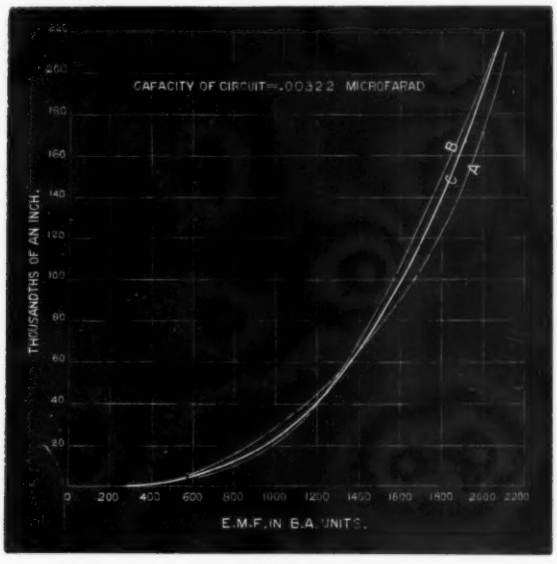

FIG. 4.

condenser, No. 3, and curve B from the results obtained from the small condenser, having the capacity ·00077 microfarad.

The curve C, in fig. 4, is very nearly the mean of curves A and B, and was calculated by this formula:

$$\frac{(\text{E.M.F.})^2 \times \text{charge in coulombs}}{a} = d.$$

Where a is a constant for the dielectric, and d is the spark length.

The charge being equal to the E.M.F. multiplied by the capacity, the formula may be written:

$$\frac{(\text{E.M.F.})^3 \times \text{capacity}}{a} = d.$$

In calculating curve C, 135 was taken as the value of a, and d was in inches, the formula then being:

$$\frac{(\text{E.M.F.})^3 \times \text{capacity}}{135} = \text{inches} = \text{length of spark in air.}$$

I am now engaged in determining the value of a for a number of dielectrics, especially those used for insulating conductors in cables, and at the same time experimental work is being done on the determination of the part this phenomenon plays in the operating of underground cables.

RAILWAY ACCIDENTS FOR THE YEAR 1887.

THE Board of Trade Report just issued shows that had it not been for the Hexthorpe accident the year 1887 would have been a "white glove" year in respect of fatal accidents occurring to passengers by train casualties. The Hexthorpe disaster was fully commented upon in our pages at the time of its occurrence. The block had been, it will be remembered, suspended, and the traffic was being worked by hand signals, when, as a train was standing at the ticket platform, a following train dashed into it, resulting in the death of 25 passengers and injury to 94 others, including two of the company's servants.

That the year would have passed without fatal accident to any one passenger had it not been for this sad occurrence renders it more than ever regrettable.

In all, the number of persons killed by the working of railways during the year amounts to 919, and the number of injured to 3,590.

Of the above, 121 killed and 1,297 injured were passengers; but of these only 25 were killed and 538 injured in consequence of train accidents. The deaths of the remaining 96 passengers, and the injuries to 759, are due to a variety of other causes, "and," the report observes, "especially to want of caution on the part of individuals themselves." Of the remainder, 422 killed and 2,075 injured were officials of the railway companies, or of contractors.

The proportion of passengers killed or injured from causes beyond their own control was: killed, 1 in 29,346,800; injured, 1 in 1,363,699. The return in this respect is not so satisfactory as many of its predecessors. Deducting the Hexthorpe casualties we should find the figures: killed, 0 in 733,670,000; injured, 1 in 1,645,000; in either case a record never hitherto attained. Indeed, it has not happened that in any year there has been no fatal accident to passengers from causes beyond their own control. The figures for the previous two years have, in this respect, been very satisfactory, viz., only 8 deaths for 1886, and 6 for 1885. Still, when we look back at 1874 with its terrible tale of 86 killed and 1,613 injured, and compare the number of passenger journeys—exclusive of journeys by season ticket holders—for that year, viz., 477,840,411, with the number for the past year, viz., 733,670,000, we may find room for considerable congratulation, and express some degree of pleasure and pride in our railway service. To what extent such a result has been influenced by the aid of electricity we are unable to say, but that it has, and does, day-by-day play its part, we know. It is by its judicious application, by the interlocking of signals and points, and by the application of the automatic break that, year by year, the increasing mass of traffic which has to be dealt with is thus disposed of with a diminished list of casualties. The result is one of which we may feel proud, and on which we may heartily congratulate our railway management.

The number of investigated accidents is again lower than for the preceding year, being but 58, as compared with 62 for 1886. The space at our disposal forbids that we should do more than glance at those cases in which the electrical arrangements or apparatus are concerned, or with regard to which it would appear electrical appliances might have been employed with advantage.

The number of accidents from collisions between engines and trains following one another on the same line of rails, excepting at junctions, stations, or sidings, were three. With respect to these we have nothing to say.

Collisions at junctions were two. One of these was that which occurred on the Great Eastern.

March 3rd.—During a dense fog a goods train from Millwall for Temple Mills, while standing at the Bow junction down home signal for the line for Fenchurch Street, was run into by a passenger train from Fenchurch Street for North Woolwich.

The collision appeared to have been due to the signalman at Bow junction in mistake having given "Line clear" to Bow Road station while the goods train was standing at the home signal. The collision would have been prevented if the goods guard had attended to the rule requiring him in foggy weather to proceed to the junction cabin, so as to keep the signalman informed of his train having been detained.

We are also of opinion that this accident would have been prevented had the electrical block signals been so interlocked with the mechanical block signals that it should have been impossible to have given "line clear" whilst the goods train was in the section.

Under the head of collisions within fixed signals at stations and sidings, we have 22 cases enquired into. Three of these are stated to have been due mainly to "mistakes of signalmen in block working arising from forgetfulness or want of care." A strong argument for interlocking!

January 14th.—A passenger train from Glasgow to Coatbridge and Airdrie, running at considerable speed during a fog, came into collision with the tender of a pilot engine standing on the up line at Rutherglen.

Two engines, a running pilot engine and a shunting engine, had proceeded out of the sidings on to the branch line, one of which returned to the sidings, the pilot engine remaining on the branch. The signalman, thinking both engines had come back, permitted the Coatbridge train to proceed, and it came into collision with the pilot engine.

March 5th.—A train from Bradford for Leeds, when running into Laister Dyke Station on the up line, during a thick fog, came into collision with the tail of a train from Bradford to Shipley, which was standing at the up platform.

The next case is that of Hexthorpe, the particulars of which we need not recapitulate.

August 27th.—An express passenger train from London for Leeds came into collision at a speed of 40 to 45 miles an hour with a coal train standing at Wath-on-Dearne Station.

This severe collision was caused by the neglect of the engine driver of the express, who ran past the distant and home signals, which were at danger, at nearly full speed. The guard of the coal train ought to have shunted his train earlier, and not to have run it so close in front of an express passenger train. The signalman at Wath did not act judiciously in signalling "Train out of section" when the goods train was standing on the down line at the station, and the signalman at Manvers Main showed a want of caution in accepting the express from Wath Road Junction at a time when he could see from his cabin that the coal train was obstructing the line.

November 2nd.—A down passenger train from Burntisland to the North came into collision at a speed of about six miles an hour with the tail of a down mineral train, also from Burntisland, which was standing with the engine between the down home and down starting signals at Kinghorn behind another down goods train standing with the engine at the down starting signal.

The immediate cause of the collision was the neglect of the driver to obey the letter of the rule as to the observance of the distant signals, but the mishap was attributed far more to the defective arrangements for working the line than to his neglect. The home signal was hardly in a proper position; more accommodation was required so as to keep the line clear for passenger trains; and block working was required between Burntisland and Kinghorn.

July 19th.—A Great Northern Railway passenger train came into collision with a North-Eastern stores train which was standing 100 yards within the signals at Whitwood Junction.

The collision was due to the signalman on duty at Whitwood Junction forgetting that the North-Eastern stores train was standing on the line close to his cabin, and telegraphing "Line clear" to Methley Station for the Great Northern train, and taking off the Whitwood Junction down home signal when the Great Northern train was approaching the junction, while the North-Eastern train was standing there.

August 1st.—As a passenger train from Blaydon to Newcastle was in slow motion between the up distant signal and up home signal at Forth Banks Junction, it was run into at the rear by a train of empty carriages proceeding from Scotswood Station to Newcastle Station.

It was suggested that absolute block working ought to be adopted—at any rate, as far as passenger trains are concerned.

Of the above extracts, the circumstances of the cases suggest that in those applying to Rutherglen, Laister Dyke, and Whitwood Junction the accidents would have been averted had the electrical and mechanical signals been interlocked. In commenting upon a collision at Spa Road Station it is remarked that "the suddenness with which fogs appear adds importance to the advantages which might be derived from the general adoption of some reliable mechanical or electric system of fog signalling."

Collisions between engines or trains meeting in opposite directions were fruitful to the extent of 6.

January 27th.—A train from Uxbridge, which had just set down its passengers at West Drayton Station, was run into by a passenger train from Staines, on the single line, the two engines meeting one another.

On the day of this accident absolute block working had been suspended, owing to the telegraph wires having been deranged by a heavy fall of snow.

It is with satisfaction we note that there is again a decrease in the proportion of servants killed and injured to the number employed. The percentage of certain of the grades is, however, still very large. We notice that for shunters is 1 in 231 killed and 1 in 21 injured.

Speaking of the "absolute block," the report observes :—"The block system has been largely extended since 1873, when 6,217 miles out of 16,082 miles only were protected by it." At the end of 1887 the progress made was as follows :—

In England and Wales			12,005	out of	13,053 miles.
In Scotland	...	...	2,280	„	2,808 „
In Ireland	...	...	557	„	2,695 „

The proportion of line now worked on the block system is 92 per cent. in England, 81 per cent. in Scotland, and 29·5 per cent. in Ireland.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 113.)

I.—INDUCTION—(*continued*).

4. *Lines of force.*—It is well known that a magnetised needle is deflected by a current in its neighbourhood, and a small needle forms a convenient instrument for investigating the condition of the space in which the coil, C, moves. Let us take, therefore, a nicely balanced needle pivotted in jewels, and commence exploring by its aid the vicinity of the coil, A. The current in the latter flows in the direction of the arrow (fig. 5), and the N and S poles of the little needle are known. In moving it about near A the first thing that strikes the observer is that the needle, when located in the same position, always assumes the same direction as regards its magnetic axis. If deflected by the finger, when held in any position it will when released, assume its former direction, nor will it assume any other until its position with reference to the coil has been changed. If in fig. 5 the shaded end of the needle represents the N pole, we shall find that the needle will take up with reference to coil A the axial directions represented. At every point in the vicinity of the coil there are certain forces acting, and lines (fig. 6) can be drawn to represent their direction, since our exploring needle always sets its axis parallel to the direction of the force exerted at the place where it happens to be situated. Circling outside the coil, entering its centre, passing through it and emerging again, these lines of force curve through space expanding into still larger and larger circles, until we get too far from the coil for the forces to be appreciable. The S pole of the needle it will be noticed points to the face, *a*, of the coil, and the N pole to *b*. In the first article we observed that the coil, A, behaved like a magnet having its N pole at *a*, and its S pole at *b*. Note, then, that an N pole attracts a S pole, and that an S pole attracts an N pole, or that poles of opposite name attract each other, while poles of similar name are repellant. If

FIG. 5.

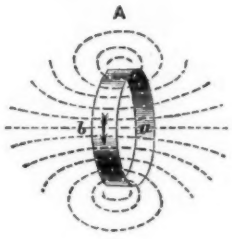

FIG. 6.

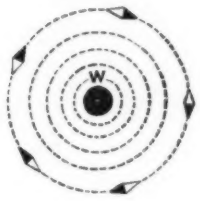

FIG. 7.

for the coil, A, we substitute a straight wire, W (fig. 7), in which a current is flowing in a downward direction, say perpendicular to this paper, we shall find the lines of force form a series of circles as shown, with the needle lying always in a definite direction for each position in the vicinity of the wire.

Let us now explore the vicinity of the bar magnet which did us such excellent service in our former experiments. Here, again, we find that the needle takes up for each position a definite direction, and we get, representing the direction of forces exerted in the

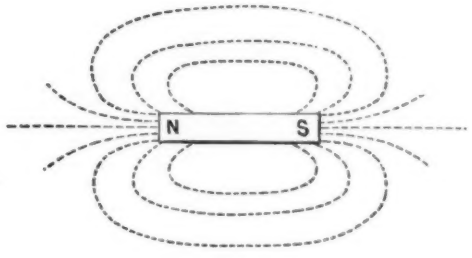

FIG. 8.

vicinity of the magnet, the lines shown in fig. 8. These are also curves like the lines of force in the neighbourhood of the coil. They proceed from the N end, say, of the magnet, curve through the air to the S end, enter there, and pass through the interior of the steel. A pretty as well as instructive picture of these lines is produced by placing on the top of the magnet a piece of cardboard, sprinkling iron filings on it, and gently tapping the cardboard the while to aid the filings in arranging themselves. The result is the beautiful

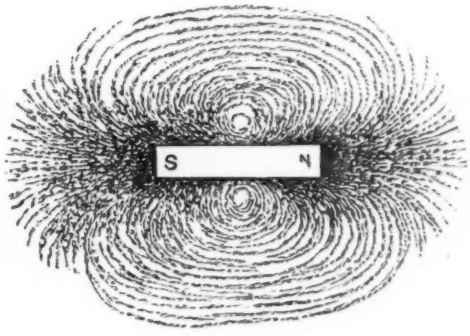

FIG. 9.

curves shown in fig. 9. Provisionally we will assume that near the coil and magnet the lines of force are more closely packed, and the force exerted greater than at some distance off. Let the steel magnet take the form of a horseshoe and we have the arrangement as shown in fig. 10. Lastly, if the magnet be a steel ring with a gap in it, the lines take the direction as in

fig. 11. The space in the region of the magnet wherein the magnetic influence is felt is termed the *magnetic field*. When on removal from this region the influence ceases to be felt the needle is said to be outside the field.

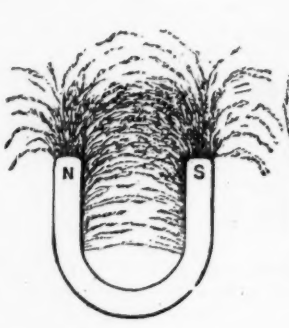

FIG. 10.

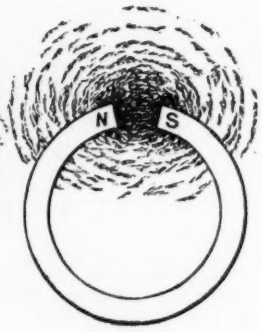

FIG. 11.

We have here a result produced alike by a current carrying coil and magnet. Both exert in their vicinity magnetic forces in well-defined directions; both create in surrounding space a magnetic field. The space in which an electromotive force is induced in a moving coil is not, we perceive, like ordinary space; it is a region in which magnetic forces are exerted. But in order that an E.M.F. may be created in this region motion is necessary. How must lines of force and motion be related in order that a current may flow?

5. *Summary of experiments.*—Having demonstrated the existence of forces in the magnetic field or space surrounding the coil and magnet, and having mapped out their directions, we proceed to consider the E.M.F. induced in the coil, C, as a result of movement in the field. We have seen that the face, *a*, of the coil, A, while the current was flowing behaved like the N pole of a magnet, while the face, *b*, behaved like the S pole. Looking at face *a* the current flows in the opposite direction to the hands of a watch, looking at *b* it flows in the same direction as the hands of a watch. Suppose the current to be flowing in A and the coil C in position

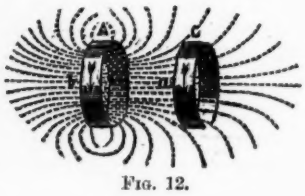

FIG. 12.

(fig. 12). There is so long as the current remains uniform no motion of the galvanometer needle. Break the current the needle gives a sudden swing showing that in coil C there is a momentary current in the direction of the arrow. We know that from A when a current flows there stream lines of force (fig. 12) which pass through the coil C. The latter is thus in a magnetic field. Stop the current this field is annihilated, and the lines of force are suddenly withdrawn from C. Simultaneously with the annihilation of the field consequent on the stoppage of the current, there is induced in C an E.M.F., and there dawns upon us some idea of these two events being related as cause and effect. But if an E.M.F. results simply from a decrease in the number of lines of force passing through the coil, the effect can be produced in another way. Place C in front of A and while the current continues to flow in the latter remove C rapidly to each of the positions 1, 2, 3, 4 (fig. 13). Each time the induced current is in the same direction showing that decreasing the lines in all cases produces similar effects, no matter by what means the reduction is effected.

The lines from face *a* of A are of the same character as the lines proceeding from the N pole of a magnet, they produce consequently similar results, as our repetition of the experiments using a magnet instead of a coil already disclosed. The current flows in C in the direction of the arrow when the latter is moved out of the field, or in the direction which makes its face next

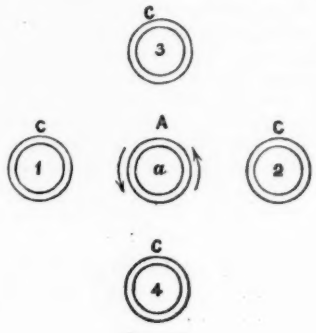

FIG. 13.

A an S pole. If lines from an N pole enter a coil a movement of the latter which diminishes the lines entering it will cause a current to flow in such direction that the face by which they enter becomes an S pole. When the movement increases the number of lines, the entering face is an N pole. If the lines entering are of opposite sign or proceed from an S pole instead of an N, the movements make the entering face N for diminishing and S for increasing. Of course N lines cannot be subtracted from or added to one face of the coil without S lines being at the sametime subtracted from or added to the other face. The above statements merely mean that when the lines through the coil are diminished the poles at its two faces are of opposite character to those from which the lines of force entering them proceed, while if the lines are increased the poles at the faces are of the same sign. As a last experiment instead of keeping the face of C parallel to A during the movement as we have hitherto done, let us give it a twist first from position 1 into position 2 (fig. 14). We find the current flows in the

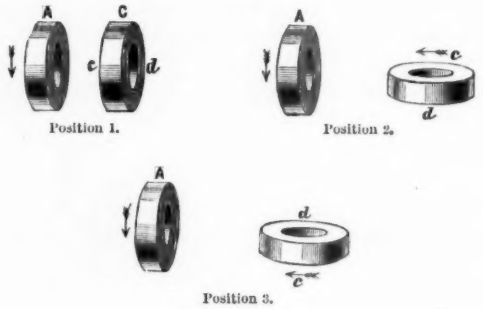

FIG. 14.

direction of the arrow. Now twist it back and the current flows in the opposite direction. Twisting it still in the same direction let it take position 3. The current once more reverses, but is in the same direction in the coil as for the first movement. The data are now fairly complete, and the following facts have been elicited:—

(*a*) An increase in the number of N lines entering a coil induces a current in such direction as to make the face by which the lines enter an N pole, or makes a current flow looking at that face in an opposite direc tion to the hands of a watch. A reduction in the lines produces poles in the coil of opposite character.

(*b*) An increase of lines coming from an N pole produces the same effect on a coil as a reduction of lines coming from an S pole, also an increase of S lines has a similar effect to a reduction of N lines. The effects are independent of the kind of movement employed to produce them.

(*To be continued.*)

ON SPONTANEOUS DETONATIONS IN THE ELECTROLYSIS OF WATER BY ALTERNATING CURRENTS.*

By MM. MANEUVRIER and J. CHAPPUIS.

I. When, in the electrolysis of water by alternating currents, we try to collect the gases by the ordinary method, *i.e.*, by directly capping the platinum electrodes with bell-shaped gas receivers, the experiment invariably ends in an explosion. The explosive gas which is liberated at each electrode detonates spontaneously at the moment when, in consequence of the filling of the receiver, the platinum wire emerges almost entirely from the liquid. The detonation is more or less violent according to the volume of gases accumulated in the receiver. It may be merely a series of slight crackling sounds, accompanied by little violet flames upon the electrodes; or it may, on the other hand, be very violent, breaking the apparatus and projecting particles of glass and acidulated water. It is sufficient for the volume of gas to reach from 25 to 30 cubic centimetres for it to become dangerous. The detonation takes place more or less quickly, according to the greater or less rapidity of the liberation of the gases; but it always does take place. It is not an accident, but a normal and inevitable fact, under the ordinary conditions of this electrolysis. We met with it, as an obstacle, at the beginning of our researches, and we were not able to proceed with them until after we had determined the causes of it by preliminary experiments, and obviated the effects of it by means of a special arrangement.

II. Long before this two eminent physicists had observed and studied analogous phenomena, De la Rive in 1837, and Bertin in 1857. It was to their experiments that we first turned for the explanation of ours.

De la Rive sent into the acidulated water of a voltameter the alternating currents of a magneto-electric machine. He found that the platinum electrodes became covered at the end of a certain time with *pulverulent platinum;* being then introduced into a receiver full of explosive gas, they provoked an explosion. The same effects were obtained with electrodes of palladium and of gold. These phenomena thus resolved themselves, to him, into a manifestation of what has been called *the catalytic force* of platinum. Bertin produced detonations of explosive gas by another method, and studied them more deeply. He decomposed the acidulated water by means of the continuous current of a Bunsen battery of 50 elements, and he collected the two gases into the same receiver. The voltameter was arranged so that the nature of the electrodes could be made to vary at will. He observed that when the receiver was almost full, sometimes the mixture detonated spontaneously with certain electrodes (platinum and platinum, platinum positive and iron negative, &c.), and sometimes it did not explode with certain others (platinum and copper, or platinum negative and an oxidisable metal positive). To him, therefore, the cause of the explosion did not lie in the catalytic force of the platinum, since other metals provoked it, neither was it due to the heating of the electrodes, which in his experiments "was inconsiderable." "These phenomena," he said, "must be attributed to the polarisation of the electrodes, of which they are the great and unwonted manifestation."

III. Neither of these explanations can be applied to our phenomena, which differ, moreover, considerably from those of De la Rive and Bertin. Nevertheless, the facts that they mention may intervene, in a certain measure, as circumstances favourable to the explosion, but they are by no means the main cause of it. Like de la Rive, we noted a black coating covering the electrodes lengthways, which might be pulverulent platinum or platinum black, but its presence is not necessary to the explosion, since this has taken place, long before its appearance, in the first testing receiver filled with gas and having a perfectly new electrode.

Like Bertin, we produced our explosions with different electrodes, of platinum, for example, with copper wires and rods of Carré carbon; the intervention of the *catalytic force* of the platinum is therefore not necessary. But neither are they determined by a particular condition, electrical or otherwise, of the surface of the metal, which would arise from its prolonged contact with the gases which are liberated. In fact, if we first fill a receiver with explosive gas, by means of a new electrode, and then substitute another new electrode, the gas explodes instantaneously, as soon as the current is sent in, provided that *the portion of the electrode submerged is sufficiently short.*

IV. The mechanism of these explosions seemed to us quite different and much simpler. The gas in our testing receivers must explode, like all explosive mixtures, as soon as it is brought into contact with one or more points of an incandescent body. Now the electrode may evidently become incandescent consequent upon its progressive emergence from the liquid; for it is subjected in this operation to three courses of progressive heating: 1, the increase in the density of the current; 2, the increase of resistance to its passage; 3, the suppression of the cooling by contact with the liquid. We have, in fact, been able to render this incandescence visible by several experiments:—

1. Our electrodes consisted of a platinum wire placed in the axis of a tube bent into a siphon; one of the ends of the platinum is soldered to a copper wire which introduces the current; the other end, soldered to the glass, emerges from it to the length of ·04 metres, and constitutes, properly speaking, the electrode. Now, we have often observed that the end contained in the glass, and thus withdrawn from the refrigerating action of the liquid, becomes incandescent at the moment of the explosion.

2. One of these electrodes having been broken, an almost imperceptible end projected from the glass. This point became incandescent as soon as the current was sent into it, and the bubbles of explosive gas arising from the electrolysis caught fire on contact with it as they were liberated.

3. This last experiment may be reproduced at will. It is sufficient to place the electrodes, not upwards but downwards, in the liquid, by the free surface, and to immerse them more or less. If only the points are introduced, we see the incandescence produced immediately with the combustion of the gases of the water that are liberated.

V. From this explanation it follows that all circumstances facilitating the heating of the electrodes in the liquid must accelerate the incandescence, and consequently the explosion of the gases. Such are the increase of the intensity of the current and the diminution of the surface of the electrodes. Thus, with platinum wires $\frac{3}{10}$ths of a millimetre in diameter, the detonation in a receiver does not take place before the gas has driven back the liquid to 5 millimetres from the point of emergence; but, on the contrary, it takes place at 25 millimetres, with electrodes of $\frac{2}{10}$ths. Inversely, all circumstances diminishing the heating will delay the explosion, and will suppress it altogether if they prevent incandescence; such is, in particular, the cooling of the electrodes obtained by their permanent contact with the liquid that is being subjected to electrolysis. An experimental arrangement realising this condition has enabled us to prevent any incandescence, and consequently any explosion of the gases collected. It consists simply in capping the electrodes, not with the receivers themselves, but with a conical or cylindrical funnel, surmounted by a little straight tube on which are placed the receivers. These may then be filled without the electrodes ever ceasing to be completely submerged. This arrangement, or any other fulfilling the same conditions, is sufficient to ward off all danger attending the manipulation of the explosive gas that is given off in this kind of electrolysis.

* *Comptes Rendus.*

ON COMPENSATED RESISTANCE STANDARDS.*

By EDWARD L. NICHOLS.

THE electrician has few more troublesome corrections to make in the course of his measurements than those arising from the influence of temperature upon resistance. Were the heating of wires due solely to changes in the surrounding air, the matter would not be a serious one. Such changes could be reduced to a minimum by devices well known in the art of physical measurements, unavoidable changes could be determined by the aid of the thermometer, the temperature coefficient for the various elements of the circuit could be ascertained and proper corrections applied.

Since, however, heat is developed in every circuit in amount measured by the product of the current and the E.M.F. between the terminals, the temperature of a wire through which a current flows is always higher than the surrounding atmosphere. In the case of heavy currents, the temperature of the wire may be very high indeed. The difficulty of applying corrections for temperature is such as to lead to frequent rejection of methods which would otherwise be of great convenience, and might lead to results of the highest accuracy.

The discovery of a substance, the resistance of which would not change perceptibly under the influence of heat, would, it goes without saying, be of great value. Unfortunately all known metals are influenced in the same sense, nor has any alloy been found which is devoid of a temperature coefficient. The exhaustive investigations of the British Association Committee in this field are too well known to need recapitulation, and while some alloys have been recently produced which are much better than anything that committee was able to discover, even these forfeit much of their usefulness on account of their low conductivity.

One substance only, among the solid conductors of electricity, seems to offer a solution of the difficulty. Carbon, as has been shown by Matthiessen,† Siemens, and many late observers, differs from the metals in showing a decrease of resistance with rise of temperature. The amount of this change, which differs widely in the case of the various artificial carbons, is given in the following table :—

TABLE I.

INFLUENCE OF TEMPERATURE UPON THE RESISTANCE OF VARIOUS VARIETIES OF CARBON.

Observer.	Variety of carbon.	Temperature interval.	Mean coefficient per deg.
Werner Siemens (*Wiedemann's Annalen*, 10. p. 560)	Gas carbon	0 to 200°	·000345
	Pressed gas carbon...	0 to 200°	·000301
Borgmann (*Journal der Russischen Physikalishen Gesellschaft*, 9, p. 163)	Charcoal	26 to 260°	·00370
	Anthracite	20 to 250°	·00265
	Graphite	25 to 250°	·00082
	Coke	26 to 245°	·00026
Kemlein (*Wiedemann's Annalen*, 12, p. 73)	Gas carbon (coarse)	18 to 200°	·000285
	Gas carbon (fine) ...	18 to 200°	·000287
	Carré's carbons ...	18 to 200°	·000321
Muroaka (*Wiedemann's Annalen*, 13, p. 307)	Paris retort carbons	...	·000300
	Arc light carbons ...	...	·000405
	Arc light carbons ...	...	·000425
	Gaudoin's carbons ...	...	·000415
	Kaiser and Schmidt's carbons	...	·000370
	Heilmann's carbons	...	·000246
	Arc light carbons ...	...	·000156
	Siberian graphite ...	...	·000739
	Faber's lead pencil graphite	...	·000588

* Read before the American Institute of Electrical Engineers, May 16th, 1888.

† Matthiessen, *Poggendorff's Annalen*, 115, p. 353.

The temperature coefficient, while varying widely for different carbons, is very nearly constant for a range of more than 100 degrees, in the case of any given specimen. It seemed probable, in view of this fact, that a conductor might be constructed by combining carbon with a metal in proper proportions, in which the influence of temperature upon the carbon and the metal respectively would precisely counterbalance each other, thus securing to the combination a constant resistance throughout a considerable range of temperature.

The calculation of the proportions necessary to this result, in the case of carbon, the coefficient of which has been determined, and a given metal, copper for example, is very simple.

Assuming that the combination would be subject to the law of parallel circuits, no alloy being formed, and no chemical combination between the parts taking place, we have for the total resistance R :—

$$R = \frac{R_m R_c}{R_m + R_c},$$

where R_m is the resistance of the metal and R_c the resistance of the carbon.

The equation of condition, for complete compensation will be

$$\frac{R_m' R_c'}{R_m' + R_c'} = \frac{R_m'' R_c''}{R_m'' + R_c''}$$

where $R_m' R_c'$ are the resistances of the components and $R_m'' R_c''$, the corresponding resistances at any other temperature within the limits of temperature for which compensation exists.

Now the variation of the resistance of a metal with the temperature may be expressed by an equation of the form :—

$$R_m'' = R_m' (1 + a t \pm b t^2),$$

where a and b are coefficients to be determined by experiment.

In the case of carbon, the coefficient a will have a negative value, and the equation will take the following form :—

$$R_c'' = R_c' (1 - a t \pm b t^2).$$

Between 0° and 100° the value of b in the case both of copper and carbon is very small. A recent determination of the coefficients for copper made in the Physical Laboratory of Cornell University, yielded the equation :

$$R_m'' = R_m' (1 + \cdot00380\ t + \cdot00000047\ t^2).$$

The experiments, which covered a range of 100°, are in close agreement with the results published by Matthiessen.

In the above equation, for $t = 100°$, we have $b t^2 = \cdot0047$. If we neglect the coefficient b and adopt for a the mean coefficient between 0° and 100°, we may write the equation in the simpler form,

$$R_m'' = R_m' (1 + \cdot003847\ t),$$

which will give results agreeing with the complete form at 0° and 100°, and will have a maximum error, at 50°, of ·0008.

In the case of carbon the coefficient, b, may also be neglected without appreciable error.

A Carré pencil, measured by another member of the same laboratory, gave as mean coefficient between 0° and 100°, the value ·000235.

We may, therefore, write the equation for this variety of carbon, as follows :

$$R_c'' = R_c' (1 - \cdot000235\ t).$$

The relative influence of heat upon the resistance of copper and carbon is shown graphically in fig. 1, which diagram will also serve to indicate the nearly constant value of the temperature coefficient of those substances.

In combining copper and carbon in such proportions that the resulting resistance shall be independent of the temperature, the following equation of condition must be satisfied.

$$\frac{R_m' R_c'}{R_m' + R_c'} = \frac{R_m'' R_c''}{R_m'' + R_c''},$$

This equation will be satisfied only for a range of temperatures throughout, in which $b^2 t$ is negligible, in the case of both substances.

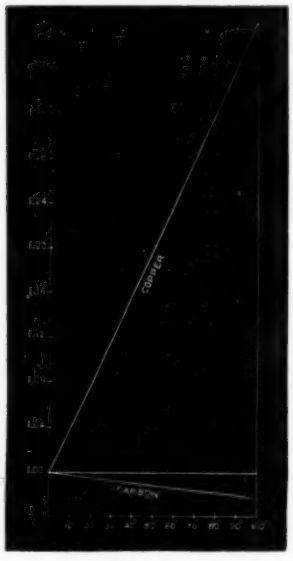

FIG. 1.

For such a range of temperatures we have, however, as already indicated

$$R_m'' = R_m' (1 + a_m t)$$
$$R_c'' = R_c' (1 - a_c t);$$

where a_c and a_m are the coefficients for carbon and copper respectively.

Within such limits

$$\frac{R_m' R_c'}{R_m' + R_c'} = \frac{R_m' (1 + a_m t) R_c' (1 - a_c t)}{R_m' (1 + a_m t) + R_c' (1 - a_c t)};$$

which is readily reducible to the form,

$$R_m' \left(\frac{a_c t}{1 - a_c t}\right) = R_c' \left(\frac{a_m t}{1 + a_m t}\right)$$

Using the coefficients already determined for copper and the variety of carbon in question, namely :

$$a_m = \cdot 003847.$$
$$a_c = \cdot 000235.$$

We find

$$R_m = 11 \cdot 544 \, R_c.$$

In a word, we must use, for every ohm of carbon, 11·544 ohms of copper in order to secure complete compensation for temperature.

Three methods of combining the copper and carbon in such a compensated resistance have occurred to me as likely to give a good result. The first method consists in wrapping an insulated wire, of the necessary resistance, around the carbon and soldering the ends to the terminals of the bar, previously copper-plated for that purpose. The second method consists in mixing the proper amount of copper in a finely-divided state with the paste of which the rod is to be made, and then molding and baking the carbon in the usual manner.

In the third method, which is the only one which I have as yet put to actual trial, the carbon, having been tested and its temperature coefficient determined, is electro-plated with copper. Experience showed that the film of copper necessary to compensation was so thin as to be scarcely adherent. The following process was therefore submitted for that of coating the entire surface. A Carré carbon 2·95 mm. in diameter was copper-plated for about 5 mm. at each end. The ends were then amalgamated and placed in mercury cups, which formed the terminals of a Wheatstone bridge. The resistance of the rod having been measured, and its mean coefficient between 20° and 100° having been determined, the length necessary for a compensated resistance of one legal ohm was calculated. The rod was then cut to the proper length, allowing 5 mm. at each end for terminals. The ends were heavily plated and were inserted into the ends of copper rods, which were carefully soldered to the carbon. The rod was then given a coat of shellac, and when dry, a strip of the varnish was removed with a sharp knife. The strip laid bare was parallel to the axis of the rod, and extended from terminal to terminal. Its width was about 1 mm. The rod was then submerged in a plating bath of sulphate of copper.

In this way a film of copper was deposited upon the exposed portion, which combined the required electrical resistance, 11·544 ohms, with sufficient thickness to render it tough and adherent. It was found that one gravity cell, acting through 50 ohms, would deposit the requisite amount of copper for a 1 ohm bar, in about 10 minutes. When the above process had been carefully carried out, the rod was found to have very nearly the proper total resistance and to be nearly perfect in the matter of compensation. If the rod was over-compensated, copper was removed by careful scraping. If it was under-compensated, carbon was removed by the same process. These final adjustments were continued until the rod showed no perceptible change of resistance when heated to 100°. When the compensation was regarded as satisfactory, the adjustment of total resistance was made by removing the copper-plating of the terminals, or extending the same by renewed plating. This, if carefully done, would bring the rod to the proper resistance without impairing the compensation. The rod, after adjustment, was well varnished, and was inserted in a glass tube of about 7 mm. internal diameter. This tube was provided with brass caps, through which the copper terminals projected to a distance of about 5 cm. These, after being securely riveted to the brass caps, were bent through an angle of 90°. When thus mounted the resistance rod presented the appearance indicated in fig. 2

FIG. 2.

In the manner just described, I succeeded after a few trials in producing a resistance rod upon which the influence of the temperature between 18° and 100° was entirely imperceptible. The object being to test the method of compensation, and not to produce a standard ohm, the adjustment for final resistance was not carried out.

The resistance of the compensated rod, after being mounted, is shown in the following table :—

TABLE II.

RESISTANCE OF A COMPENSATED RESISTANCE ROD AT VARIOUS TEMPERATURES; MEASUREMENTS BY MR. GEO. D. SHEPARDSON.

Temperatures.	Resistance in B. A. ohms.
105° C.	1·0300
98°	1·0300
87°	1·0305
35°	1·0305
22·5°	1·0295
19°	1·0300

For the purpose of this measurement, the rod was immersed in an oil bath and heated to more than 100°. The readings were taken while the bath was cooling. They indicate a practically perfect compensation throughout the range of temperature given in the table.

If such a compensated resistance rod be quickly heated or cooled, the copper will change more promptly than the carbon and the balance will be temporarily destroyed. While in process of heating from without, the resistance will increase somewhat, and while cooling by radiation the reversed effect will be noticeable.

In rods not mounted in glass and unprotected by a coating of varnish these variations are very marked. Table III. contains a set of readings made upon such a rod. The rod was rapidly heated and cooled, and was measured several times during the rise and fall of temperature. The compensation was nearly complete, the mean coefficient between 20° and 100° being less than ·00002, but the rod in question exhibited temporary variations when suddenly heated and cooled, amounting to more than 1 per cent.

TABLE III.

TEMPORARY VARIATIONS OF A COMPENSATED ROD SUBJECTED TO SUDDEN CHANGES OF TEMPERATURES.

Temp.	Resistance.	Temp.	Resistance.
25°	1·0050	78°	1·0030
(Gas ignited)		(Gas extinguished.)	
37°	1·0072	78°	0·9965
45°	1·0074	74°	0·9960
55°	1·0070	63°	0·9975
62°	1·0040	40°	1·0030
68°	1·0040	25°	1·0050
70°	1·0040		

Compensated resistance bars, such as have been described in this paper, are of course limited in their application to uses in which carbon conductors are admissible. For standards of resistance I think they will be found especially valuable. The convenience of having a comparison resistance the value of which can be determined once for all, and which can then be used with confidence, without regard to its temperature, even in circuits which would heat our ordinary standard coils and modify their resistances to a notable extent, will be appreciated by all. In the construction of low-resistance shunts, also, the possibility of obtaining a conductor which will remain unchanged at all ordinary temperatures, whether heated from without or by the passage of the current, will permit us to adopt with confidence the use of high resistance galvanometers, with low resistance shunts, for the measurement of large currents, even where the highest accuracy is necessary.

To those who, in the course of their electrical work, have to cope daily with the question of the influence of temperature upon resistance, numerous other applications of compensated resistance rods will suggest themselves.

NOTES.

Bath and Weston.—The price of gas for public lighting at Bath is 1s. 11d. per 1,000 feet.; yet the increased cost of lighting by electricity is estimated at only £203 per annum. Gas is 2s. 7d. per 1,000 feet at Weston-super-Mare, and Weston people want to know if a saving on the present cost could not be effected by the introduction of electric lighting.

Lighting Tramcars by Electricity.—On Monday, at Exeter, a practical illustration was afforded the public of the suitability of the electric light for the illumination of tramcars. Two 5 C.P. incandescent lamps, supplied by the Eclipse Electric Syndicate, London, were temporarily fitted to a tramcar. The arrangements were carried out by Mr. E. W. Clifton, representing the syndicate, and the result of the experiment was said to be satisfactory.

The Lighting of Temesvar.—As our readers are aware, the Anglo-American Brush Electric Light Corporation, Limited, made the electric lighting plant for the public illumination of the streets at Temesvar, and has for some years been working that installation. The Corporation has now decided to undertake the lighting of private houses also, and to adopt for that purpose the Zipernowsky-Déri-Blathy system of electric lighting by transformers, and has already ordered the necessary material for this new installation, which is to be furnished by Messrs. Ganz & Co., of Budapest.

Electric Lighting in Scotland.—Mr. Rankin Kennedy, of Woodside Electric Works, Glasgow, has recently fitted complete installations of electric light on the following steamers:—The *Smith* and *Cass*, two passenger ships built by Messrs. R. and W. Hawthorn, Leslie and Co., Limited, for the Formosa Trading Company, China; the *Tynesider*, owned by the Tyne Steam Shipping Company and trading between Newcastle and London; the *Paula* and *Cavease*, two oil carrying steamers, built by Messrs. Sir W. G. Armstrong, Mitchell and Co., Limited, Walker Shipyard; the *Trieste C.*, a small passenger steamer for the Adriatic, built by Messrs. Wm. Simons & Co., Renfrew, and the *Leon y Castilio* and *Verda y Glavajo*, two steamers built by Messrs. D. J. Dunlop & Co., Port Glasgow, for the Canary Islands passenger and goods trade. In addition to the above the firm has now on hand three steamers, the *City of Oxford*, *Cambridge* and *Calcutta*, for the City Line of Messrs. George Smith & Sons, Glasgow, two large oil carrying steamers for Messrs. Sir W. G. Armstrong, Mitchell & Co., Limited, and a number of other shipping and land installations of considerable importance. Mr. Kennedy has now completed, and is using exclusively for ship lighting, his double cylinder single acting engine. It is being very favourably received, and is giving universal satisfaction; where direct driving is desirable it is specially applicable. We hope shortly to publish a full description and results of tests of this engine. The manufacture of a new incandescent lamp of large C.P. has been commenced at Woodside Electric Works.

Kensington and the Electric Light.—Kensington is determined to be cautious in its dealings with the electric light. At the last meeting of the vestry, the Law and Parliamentary Committee reported, and the Works Commitee expressed its approval, as follows:—That the committee have considered the questions referred to them by the vestry on the 27th June, as to the request of certain electric lighting companies for the approval of the vestry to application being made to the Board of Trade for a licence to supply electricity within the parish of Kensington, and also notices of the intention of certain companies to apply for provisional orders subsequently given, viz.:—Kensington Court Electric Lighting Company, Limited; Kensington and Knightsbridge Electric Lighting Company, Limited; London Electric Supply Corporation, Limited (known as the Grosvenor Gallery Lighting Company); Notting Hill Electric Lighting Company, Limited; House to House Electric Light Supply Company, Limited; Chelsea Electricity Supply Company, Limited; South Metropolitan Electric Supply Company, Limited; West Middlesex Electric Lighting Company, Limited; and recommending that the vestry refer the consideration of all such applications, together with all other matters relating to electric lighting, to a special committee of 18 members, to consist of the nine members of the Works, Sanitary and General Purposes Committee now forming the Electric Lighting Sub-Committee, and nine members to be selected by the Law and Parliamentary Committee, for consideration and report. Also that the clerk be instructed to request the above-mentioned companies to supply the vestry with the following documents and information where not already furnished:—Memorandum and articles of association; balance sheet (where company is in operation); if no balance sheet, capital subscribed and paid up; capital proposed (where company is not in operation); prospectus issued; list of shareholders; map of area proposed. The report was agreed to.

Three New Cables.—The *Toronto Mail* states that Mr. F. N. Gisborne, electrical engineer of the Public Works Department of Canada, will visit the North-West and British Columbia on official business this fall. Before doing so he will lay three Government cables, one between Kingston and Howe Island, the second from Howe Island to Wolf Island. The third cable will connect Pelee Island in Lake Erie with the mainland. The latter cable will weigh 21 tons.

Electric Lighting Contracts.—On the motion for confirming the minutes of the electric lighting committee at a recent meeting of the Leeds Town Council, Mr. Willey expressed surprise that the committee had accepted the tender for dynamos of a firm at a distance, whose charge would be 50 per cent. higher than the tender of a Leeds firm, who had assured the committee that they would supply as good an article as was in the market. He understood there was a very strong feeling on the committee in favour of giving the contract to the Leeds firm. Alderman Spark said that while the committee were desirous of keeping the work in the town if they could with a due regard to efficiency, yet their experience was not such as to induce them to do anything in the nature of experimenting. A comparison of the work done by the two kinds of apparatus before them convinced the committee that as to price they were about alike. The minutes were adopted.

American Institute of Electrical Engineers.—Mr. Ralph W. Pope, the secretary of the above institute, writes to us with reference to one of our recent leaderettes :—"In regard to the election of Mr. Saxelby, which you have commented upon, I desire to say that the statement that he has been elected a *member* is not correct. He was, however, elected an *associate*, to which grade his long service with Mr. Edison in the electrical field fully entitles him, especially when endorsed by gentlemen of the standing of Messrs. Edison and Upton as he was."

Suggested New Cable.—The cost of cable messages between London and Demerara is 14s. per word, an almost prohibitive rate. This is caused by the fact that all messages have to go a round-about way through New York. Moreover, the time taken is inordinately long. Mr. Samuel Vyle, the Government electrician of Demerara, thinks this could all be rectified by a new cable connecting Demerara with the Cape de Verde Islands. This would have the effect of placing both ends of the cable connecting the West Indian Colonies with the Mother Country in the hands of the Government, and of reducing the price at which cable communication would be possible to less than one-half of the present rate.

Atlantic Cable Repairs.—The Direct United States Cable Company informs us that its main cable between Ireland and Halifax (Nova Scotia) is now in efficient working order.

Western Counties and South Wales Telephone Company.—On Wednesday last week a meeting of the shareholders of this company was held at the offices, Bristol, for the purpose of confirming a special resolution for extending the borrowing powers of the company. The Chairman (Mr. C. Nash) pointed out that it was necessary that they should be in a position to obtain the capital necessary for the extension of their telephone system. They were hoping almost immediately to open an Exchange at Cheltenham and connect it with Gloucester, and he did not think it would be long before they got an important extension in the south. It was hoped shortly to connect Winchester with Portsmouth, and Southampton and Bournemouth would ere long be brought into communication. In the Plymouth district it was proposed to connect Tavistock with the Three Towns, and also to carry a line from Plympton to Totnes, thus enabling Torquay to speak with Plymouth. The special resolution, which was to the effect that the company might borrow any sum of money on such security and terms as to interest as it might deem fit, and that it might secure the same by mortgage or other debentures, but that not more than £20,000 should be owing at any time without the consent of a general meeting of the United Telephone Company; and, further, that the borrowed money should carry interest at no higher rate than 6 per cent. per annum, was then adopted.

The Telephone in Mines.—At a recent meeting of the Mining Association and Institute of Cornwall, Mr. T. Scott Anderson, district manager of the West of England and South Wales Telephone Company, read an interesting paper entitled "The Telephone : its application and development," in the course of which he mentioned that he had held a conversation, and that distinctly, through coils of wire representing 180,000 miles, although, of course, such a feat was not practicable along a wire running on poles. The great utility of the telephone in mining operations had been amply demonstrated in Cornwall and in the collieries of the North. Not long since a poor fellow was crushed underground in a mine near Camborne. Thanks to the telephone, the accident was known at the surface in five minutes, and the injured man, who if aid had been long delayed would probably have died, was brought up in the "skip." Nothing could be imagined of more paramount importance than a ready means of communication in mines. Each working level of a mine could be placed in direct communication with the surface and every other level for about £5 a year; thus if three underground workings were required to be joined to the surface, the cost per annum would be about £20. The room in which the lecture was delivered was placed in communication with the 388 fathom level at Dolcoath.

Electric Lighting in the City.—"Dogberry" writing in the *City Press* says:—"I am glad to know that the question of electric lighting is again to be seriously entertained by the Commissioners of Sewers. The negotiation last year with the Anglo-American Brush Corporation failed on three points which easily admit of arrangement. In fact, the most important has already been settled by the new Electric Lighting Act, which fixes a maximum price for private supplies. The second point was the fear that the monopoly granted for a limited period would develop into a practical freehold, but this I am told the Anglo-American Corporation are willing to vacate, and are ready to fix at once a price at which the plant and machinery may be taken over. Lastly, I hear they are willing to extend the area of their installations, and will include the eastern wards ; so that on the whole we may expect the coming winter to be the last in which the City of London will lag behind provincial towns, and even such straggling mining settlements as Kimberley, South Africa, in the matter of nocturnal illuminations."

At a meeting of the Commission of Sewers last week, notices were received from the South Metropolitan Electric Supply Company, and from the London Electric Supply Corporation, of applications to the Board of Trade for provisional orders for powers to supply electricity for lighting and other purposes within the city.

The Frog Who Would A-Wooing Go.—One of the *Standard* staff reporting the Naval Manœuvres relates an amusing incident in connection with the accidental explosion of one of the mines. By the way, the incident seems to suggest the possibility of an actual instead of a merely make-believe explosion when serious operations are being carried out. The *Standard* correspondent says :—"An elaborate system of invisible wire is spread around this battery in a variety of directions, so that no one can approach from the land side without tripping against an obstacle, and thereby exploding a mine which will theoretically blow him to pieces. An eccentric frog, which came leaping home late last night, failed to note this wire, and started the mine, to the great alarm of the guard and the Fleet, who naturally supposed that the camp was surprised by the enemy. When, however, the frog was found to be the key to the mystery, there was a general feeling of relief, not unmingled, however, with a certain anxiety lest each night to come should be disturbed by frogs, field mice, or other wandering creatures."

Telephone Distinction.—The Western Counties and South Wales Telephone Company has been successful in obtaining the highest award—a silver medal—at the Mining Exhibition.

Two Electric Lighting Companies.—The total loss of capital of the Provincial Brush Electric Light and Power Company amounted to £51,096, that of the South Eastern Brush £45,953. Nearly £100,000 gone never to return. Unhappily, it is not unlikely that such farces will be enacted again, even in the light of the knowledge of the present day.

Gülcher (New) Electric Light and Power Company.—The first ordinary general meeting of this company was held yesterday (Thursday) at the Cannon Street Hotel, under the presidency of Mr. Daniel de Castro. The following resolution was proposed and carried :—

"That the articles of association of the company be amended as follows :—Article 7, by omitting all words after the words 'ordinary shares,' and in place thereof inserting, 'the preference shares shall be entitled to receive out of the net profits of each year a preferential dividend of £10 per centum. After provision has been made for such preferential dividend, the surplus net profits, or so much thereof as shall be sanctioned at the annual meeting of the company, shall be distributed upon all the shares, both preference and ordinary, ratably in proportion to the amount paid up or credited as paid up thereon respectively. In the event of a winding up of the company, the surplus assets shall be applied first in repayment to the holders of preference shares of the amounts paid or credited as paid thereon; then in repaying to the holders of ordinary shares the amounts paid or credited as paid thereon; and the residue shall be divided as to one third part amongst the holders of the debenture stock of the company; as to one other third part amongst the holders of preference shares; and as to the remaining third part amongst the holders of ordinary shares.' Article 12, by inserting after the word 'registration' the words, 'and shall have been duly registered as a shareholder in the books of the company, whereof the production of a share certificate in his name shall be sufficient evidence.' Article 46, by striking out the words, '31st December,' and in lieu thereof inserting '30th day of June.' Article 60, by inserting after the word 'member' the words, 'who shall be registered as a holder of a preference share or shares.' By inserting after the word 'each' the word, 'such.' By adding at the end of the article the words, 'and every member who shall be registered as a holder of an ordinary share or shares, shall have one vote for each such share up to five shares, and one vote for every additional five shares beyond the first five shares held by him up to fifty shares, and an additional vote for every ten shares held by him beyond fifty shares.' Article 75, sub-section (*e*), by inserting after the words, 'Acts of Parliament,' the words, 'Provisional Orders.' Sub-section (*j*) by inserting after the word 'debenture,' the words 'or debenture stock.'"

The chairman explained that the alterations were rendered necessary by the fact that there had been a difficulty in raising the £20,000 by preference shares proposed to be issued under the first prospectus, only £12,000 being applied for. With the consent of the subscribers for that £12,000, it was decided to provide the remaining £8,000 by the issue of debenture stock; all the shareholders were informed, and fresh prospectuses were sent out. The alteration of article 12 was considered advisable, in order to prevent any large shareholder from splitting up his shares and transferring them to his nominees a few days before a meeting for voting purposes. The reason for the alteration of article 60 was to prevent the deferred shareholders from being in a position to outvote the preference, a precaution necessitated by the failure to raise the £20,000 by preference shares.

The Maxim-Weston Company.—The *Financial News* is officially informed that Mr. Hugh Watt, M.P., has resigned his position of director and manager of the Maxim-Weston Electric Company, and that the board has accepted the resignation. The engagement of Mr. J. Wright (the secretary) has also been terminated, and the company's offices have been removed to No. 2, Metal Exchange Buildings, Gracechurch Street. This is so clean a sweep, says our contemporary, as to suggest the Brush rather than the Maxim-Weston. The Liberal Association of the Camlachie Division of Glasgow has asked Mr. Watt to resign his seat for that constituency; in fact, Mr. Watt had better begin to resign himself—to the inevitable.

"Niagara" in London.—If the lighting of "Niagara" in London is always on a par with what we saw a few evenings since, we think it would be hard to beat. Independently of the very realistic falls and their beautiful surroundings, which is a sight well worth going a long way to see, the arc lighting will not fail to impress electrical men as a fine example of its kind.

Red-Tapeism.—The *Echo* has the following :—"A curious story is just now being told of the Post Office Telegraph Department. A certain large hotel in London wishing for a telegraphic code word, applied to register its own name, a very uncommon one, for the purpose. After some consideration, the official to whom the question was referred decided that the application could not be granted, and that the hotel must receive some meaningless arrangement of letters from him. An appeal was made, and was sent to the department, when for month after month it passed from office to office, till at length it reached the supreme head. He at once, seeing the absurdity of the situation, sent down word that the request was to be allowed. But routine would not allow of this being done till the new order had actually gone the same round as the application, and upwards of several months had been spent in again discussing it! No wonder the Telegraph Department does not pay."

Midland Institute of Engineers.—At the annual meeting of this institute, held at Barnsley, Mr. T. Carrington, in submitting the toast, "The mining interests of the county and the coal trade," said, in noting the state of trade, that the black cloud of depression which had so long overhung the coal trade had not yet passed away, nor did he see any immediate prospect of it. They used to look to foreign countries as their best customers, but now they were their competitors. Petroleum was becoming adapted for heating purposes, so that all the vessels built by the Italian Government were fitted to use it. The electric light was so far developing that it must become a serious factor to those engaged in the production of gas. With such unpromising facts before them, they could hardly drink the toast with enthusiasm."

Lightning Conductor Work.—The whole of the lightning conductor system at the Whittingham County Asylum, Preston, is being extended, and new earth plates inserted to insure a more perfect termination; also twenty new lightning conductors are being erected for the further protection of this extensive establishment. The registered system of Mr. Jos. Blackburn, of Nottingham, has been adopted, and the work is now being carried out by that firm.

Lightning Conference.—The organising committees of sections A and G of the British Association have arranged a joint discussion on "Lightning Conductors," to be held at the Bath meeting in September. Mr. W. H. Preece, F.R.S., will open the discussion, and Prof. Oliver J. Lodge, D.Sc., F.R.S., will defend the position he took up this year before the Society of Arts.

Theatre Lighting.—The *Sunday Times* says that the electric lighting at the Lyric will be in the experienced hands of Mr. Emile Sechelaye, of Viennese fame.

At the recent meeting of the renters and debenture holders in the Drury Lane Theatre, Mr. Pyke expressed surprise that the theatre was not lighted by electricity; but the Chairman thought the matter might be allowed to slumber a little to wait developments.

The Bankruptcy of John Faulkner.—The Judge of the Manchester Court has granted a discharge to Mr. John Faulkner, whose failure was brought about by the expense attending the defence of an action for infringement of a telephone patent. The official receiver expressed his opinion that the case was one for sympathy, both with regard to the debtor's state of health and other circumstances.

Amateur Central Stations.—Just as we are going to press we have received the following letter:

"106, Cheapside, London, E.C.,
"*August 8th*, 1888.

"Gentlemen,—I have been consulted by Mr. John Kent, the proprietor of Electric and Telegraph Schools, Railway Approach, London Bridge, with reference to a libel published by you in the TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW of the 3rd inst., and which is contained in Mr. Wallace J. L. Sandy's letter. I am instructed to commence legal proceedings both against you and Mr. Sandy, for which purpose I shall feel obliged if you will favour me with the name of your solicitor, who will accept service on your behalf; at the same time I must request you to furnish me with Mr. Sandy's address, unless you are prepared to take the entire responsibility of the libel upon yourself.

"Yours obediently, H. E. KISBEY.

"Messrs. Alabaster, Gatehouse & Co.,
"22, Paternoster Row, E.C."

[At the same time that we fail to detect in the letter complained of anything in the nature of a libel, we have no hesitation in expressing regret if the remarks appearing in our columns are calculated to injure the prospects of the Electric and Telegraph Schools. We certainly thought that any adverse opinion which might have been formed by reading the letter would have been dispelled by the editorial note which followed it.—EDS. ELEC. REV.]

Lamps for Warships, &c.—It is a matter of common knowledge that incandescent lamps suffer considerably on board ship from the inevitable vibration, and especially on warships, where the shocks produced by firing the heavy guns now in vogue are particularly destructive to filaments. Messrs. Woodhouse and Rawson have just brought out a new type of their unflashed lamp for this particular purpose. The filament is very short and broader than that usually used. The natural resistance, also, of the filament is higher than that of the lamps made with flashed filaments. It is the attention to small details of this kind which helps forward electric lighting.

The Daft Company.—The Daft Electric Light Company of New York has issued an illustrated description of its operations under the title of "Distributory Electrical Power Plants." It is beautifully printed by one of its customers, a firm of printers which uses a 15 H.P. motor to drive 12 presses as well as to supply power for other machines in the same building. A list is given of the company's patrons, showing that the uses to which they put the power includes sewing machines, printing presses, elevators, machine tools, lapidaries' and opticians' wheels, pumps, and ventilating fans. The company is making a speciality of transmission of power, believing that the electrical distribution of power in towns merits separate and exhaustive treatment. What a pity it is that the company did not choose a less suggestive title.

A Disclaimer.—Mr. J. Morris writes to us that he, having no connection whatever with the Medical Battery Company (Harness & Co.), wishes us to state that the letters M.S.T.E., affixed to his name in their publication, *The English Home*, were used by the publishers without his knowledge or consent, as he was unaware of the fact that they were thus proposing to use an obsolete title until he heard that it was in print. Mr. Morris was a member of the Society of Telegraph Engineers for some years, and was their secretary in Japan. All this, however, does not touch the main point at issue, viz., the authorship of the paper upon which we commented.

Good Earth for Lightning Conductors.—In selecting and fixing an effective lightning conductor it must be remembered that a good earth is desirable. Dr. Oliver Lodge says:—"A few tons of coke with the conductor coiled up amongst it is a well known and satisfactory plan if the soil be permanently damp. A bag of salt might perhaps be buried with it to keep it damp throughout, or rain water may be led there. Often, however, the most violent thunderstorms occur after a spell of fine weather, and the soil is likely to be dry. It is best, therefore, to run your conductor pretty deep, and there make earth. It is all very well to connect the conductor to water-mains if near, but if they are far off or non-existent it is no use; and in no case, in my opinion, should they be used as sole earths. Certainly not gas mains. In dry weather they are not earthed at all well, and a strong charge may then surge up and down them and light somebody else's gas in the most surprising way. It does not often happen, but it may happen in sandy soil after dry weather. Always there should be a good deep earth—a well if possible, a boring if not—and the conductor be led down into it. If it likes to make a disturbance when it has to leave the conductor a long way down, no one need grumble. It can't do much harm there. There is, of course, no magic in water, unless it forms a large continuous sheet. A thoroughly good earth is really a geological question; and for an important building a geological specialist should be consulted. An occasional test of an earth, in ordinary weather, is no real security as to what may happen after a long-continued drought."

Bristol and the Electric Light.—The *Bristol Mercury* says: The subject of the electric lighting of the centre of the city has not, we are assured, been overlooked by the Sanitary Authority Committee, and they are only deterred from taking action by the fact that the cost of illuminating by electricity far exceeds that of gas. When the matter was first mooted enquiries were made with a view of ascertaining whether the principal firms in the main thoroughfares of the central ward would become customers of the committee and introduce the light into their establishments, thus diminishing the cost of the installation to the city. The replies, however, were not of a favourable character, and the matter was dropped, but the committee keep themselves in communication with Mr. Preece, the chief electrician at St. Martin's-le-Grand, London, and are keenly watching the development of "the light of the future."

Killed by Lightning.—An inquest has been held on the body of James Robinson, aged 27, an excavator, who was killed by lightning. Robinson was employed at Barking, and on Monday night last week with four companions walked along the Sewer Embankment towards Plaistow. During their journey a storm came on, and Robinson and two men named Stacey and Randell were struck by lightning. Stacey was hurled some distance, but recovered consciousness, as did Randell after a time. Robinson, however, was killed instantly, his hat being shattered to pieces. Dr. Ross said that he found a series of scorchings on the body and also a wound over the left ear. The man was wearing a hat the edge of which was surrounded by steel wire, and the doctor thought this steel had attracted the electric fluid. The jury returned a verdict in accordance with the medical testimony.

On Tuesday afternoon last week two young miners, named James Galloway (20) and Robert Kennedy (16), were returning from work at Longrigg pit (James Nimmo & Co.'s), and were in the midst of a field on the farm of Longriggend when they were both struck by lightning. Both miners were carrying their picks on their right shoulders, and when struck Galloway appeared to have been killed on the spot. Kennedy, however, was merely stunned.

Removal.—The Bernstein Electric Lamp Company has removed to 2, Marlborough Mansions, Victoria Street, Westminster.

Barry Docks and Railways.—The contract for the erection of telegraphs on this company's lines has been given to Messrs. J. B. Saunders & Co., electrical engineers, Cardiff. The company is wisely having the work carried out in a most substantial manner, with the view of protecting their communication against damage from snowstorms, &c. Tyer's block system is being adopted throughout, single needle instruments and Gower-Bell telephones being employed at the various signal cabins. Pontypridd, Cardiff, and all the chief stations on the line will be in telephonic communication with the company's general offices at Barry, the longest telephone circuit being over 20 miles. The new dock is a magnificent piece of work, and is to be lighted throughout by electricity. The general manager is Mr. Richard Evans, a gentleman of vast railway and dock experience, and known throughout South Wales for many years past in connection with the Rhymney Railway.

Lightning Rod Sharpers. — The lightning rod swindlers are working a new scheme, and one calculated to catch a fellow, says the New York *Electrical Review*. The farmer is first called upon by a pair of slick-tongued chaps who inform him they are sent out by insurance people to examine lightning rods ; that the losses by reason of defective lightning protectors have become so frequent and heavy that the companies, in self-defence, are compelled to look after the matter and remedy the defects so far as it lies in their power. An electric battery is produced, the farmer coupled on to the handles, the lightning rod being in circuit, and the current not being turned on, he feels no shock. Then they produce a sample of lightning rod which they can furnish the farmer, and to show him how perfectly the electricity is changed to their rod, and the machine being very heavily charged this time, the farmer gets a shock which is almost a knockdown argument. Of course, the bait is swallowed, and the victim signs the contract, and in a day or two along comes the second division of the gang, who put up the rod. About this time the farmer receives another and harder shock by being presented with a bill largely in excess of his expectations. No use kicking, for his contract stares him in the face, and he can do nothing but make the best of a bad bargain.

Dangers of Electric Lighting.—A Mr. Harold P. Brown, calling himself an electrical engineer, recently wrote in the New York *Evening Post*, alleging that grave dangers were to be apprehended from the use of the alternating current system and setting forth certain precautions which he contended should be observed by the Board of Electrical Control. That board sent out invitations to prominent electricians to answer the remarks and allegations of Mr. Brown, and they have done so to an extent and in a manner that must make Mr. Harold P. Brown feel particularly small.

Structure of a Flash of Lightning.—M. E. L. Trouvelot, during the storm of June 24th, at Paris, succeeded in obtaining the photograph of a flash of lighning, and submitted the proof to the Academy of Sciences on the 9th inst. This flash, which seemed to connect the earth to a cloud, subtended an angle of 40°. The flash appears divided in four main branches, brilliant and strongly marked. But there were others less visible, some so faint that they could not be seen in the negative without the help of a lens. The total number of the branches, large and small, is 37. A microscopic examination of the image of the flash shows that it is like a long ribbon, taking all the forms which a ribbon might present if plunged into a slowly moving liquid. This ribbon seemed to be traversed vertically by a multitude of rays more or less close together, and more or less brilliant. They are seen almost everywhere upon the flash, even upon its faintest ramifications. They correspond in general with the fracture of the zigzags which seem to make up the flash.

Carbons for Arc Lights.—We are informed by M. Mayer the resident agent of M. C. Conradty of Nuremberg, that the latter has secured the contract for the supply of his well known carbons for the whole of the railway stations of Alsace-Lorrain, notwithstanding the fact of there being several lower tenders, the excellence of quality as regards brilliancy of light and time of burning being in this instance the greatest object.

Converts to Electric Railways.—The appearance of Mr. Henry M. Whitney before the selectmen of Brookline, Mass., as an advocate of electric railways, says the *Electrical World*, deserves special notice on the part of all interested in street railway enterprises. Mr. Whitney's West End Company of Boston proposed to put in a cable system, and had made all the necessary preparations, believing that electricity was not yet ready to do such heavy work as would be demanded. But Mr. Whitney was not satisfied until he had made an examination of the results obtained with electricity at Richmond, Va., and Allegheny City, and, as might be expected, after seeing with his own eyes what electricity can do, he is a thorough convert to the new power. His speech before the Brookline board was one of the most eloquent and convincing arguments yet presented in favour of electric locomotion. "I believe," said Mr. Whitney, "that the electric motor at this day has reached that stage of development which makes it a perfectly practicable working machine, superior in all respects to horses for quick transportation," and he goes on to point out its advantages also over the cable. Such evidence as this from the outside is not to be gainsaid. It is simply the recognition by a leader in the world of finance and commerce of the claims that have been made by electricians, and it will stand, every month giving it greater weight and validity.

Electric Launches.—At the time of the Henley Regatta Mr. Immisch's electric launches attracted a considerable amount of attention, and last week the *Volta*, designed by Mr. Reckenzaun and constructed by Messrs. Stephens, Smith & Co., showed herself on several occasions. This vessel is an old acquaintance of ours, and we have on several occasions enjoyed very pleasant river trips which have shown her to be trustworthy in every way, but under no circumstances do we remember her to have behaved in a more exemplary fashion than on Saturday last, when she ran from Millwall to Richmond and back under the disadvantages of tide and wind against her, the former in both directions. With Mr. Immisch's proposed charging station up the river we see no reason why electric launches should not become quite fashionable, and Messrs. Stephens, Smith & Co., with their extensive experience in all work connected with marine engineering, and with Mr. Reckenzaun to fall back upon for technical advice, ought jointly with Mr. Immisch to show the way in this branch of electrical propulsion.

A Slight Mistake.—The articles in *Money* written by "The Capel Court doorkeeper," must be very amusing to the financial fraternity, and occasionally one comes across things which are suggestive enough to apply to electrical matters. The following is an instance :—"I ain't'ad so menny chats with the brokers lately, although I did get a werd or two with Mr. Arthur Anderson. After kongratterlating him on 'aving his name in the *World*, I arsked 'im wot 'e thort ov 'Her Majesty's Theatre Company, Limited.' 'Joseph,' sayz 'e in 'is usuall aristocratic manner, 'you no wot's going on in the Empire, and is it likely there can be room four two such failures ?' 'But don't yew think they mite do better, being a bigger place ?' 'I never sez wot i thinks, Joseph,' he said, and marched orf with his cote tales between his legs." At a casual glance this might have been taken as a reference to theatre lighting by electricity, but after long and grave consideration, we have come to the conclusion that it is intended for something quite different.

What is a Dangerous Voltage?—Mr. C. S. Peck, in a paper read before the Board of Electrical Control in New York on the 16th of last month, stated that 1,000 volts pressure has never yet proved fatal to human life. This is a grave error, as there are several well authenticated instances of death from shocks derived from both direct and alternating current systems of a less voltage than that quoted. We freely admit that to the general public the danger from alternating currents since the advent of transformers has become infinitesimal; but to those who have charge of the generating machinery, this immunity from shocks does not apply.

A Nice Question.—Dr. Oliver Lodge, whose admirable lectures upon lightning are now the subject of some articles from the pen of Mr. S. A. Varley, would do excellent service in the cause of humanity, and earn everlasting gratitude, if he would only investigate in like manner the dangers to be apprehended from the use of electric lighting apparatus and the means for avoiding them. Could he not settle once for all the question as to whether the current from open or closed coil armatures is equally dangerous? At present it seems to be purely a matter of conjecture, although the majority of engineers would doubtless argue that a shock from the open coil type is the more likely to prove fatal. Again, it is often contended that when death results from contact with a dynamo, it results from the after current or "kick" of the machine; but that this is not necessarily the case, is shown by the fact that fatalities have been traced to simple connection with an earthed wire. Perhaps Dr. Lodge will not be loth to undertake the investigation of a subject of so much importance; and in the meantime if our readers can send us any authentic information which will help to reduce conjecture to absolute fact we shall be pleased to receive it.

A Foreign Invasion. — Not long ago we hinted that it would probably be left to American enterprise to show us how to work electrical tramways on a successful commercial basis. We little thought at the time of making our comments that so short a time would elapse before their truth became apparent, but the Sprague Company is now carrying the war into our own camp. Still this is not a campaign of extermination, but rather a friendly bout which we hope will bear good fruit, and we welcome the American invasion accordingly.

NEW COMPANY REGISTERED.

Morewood & Co.'s Successors, Limited. — Capital £40,000 in £5 shares. Objects:—To trade as iron and brass founders, electro-platers and galvanisers, and for such purposes to take over the business heretofore carried on by Morewood & Co., Limited, and by Charles Lee Nicols the liquidator thereof. Signatories (with one share each) H. G. Heathfield, Edgbaston, Birmingham; E. K. Little, Leamington; Rev. C. Y. R. Bedford, Sutton Coldfield; *S. Saunders, 79, Colmore Row, Birmingham; J. H. Saunders, 110, Cannon Street; *W. P. Pomfret, M.P., Ashford, Kent. Directing qualification, 100 shares. The first directors are the signatories denoted by an asterisk, and J. Timmins Smith, of Stratford-on-Avon, and R. W. Linsay, of Barford, Warwick. Registered 3rd inst. by Beale and Co., 28, Great George Street, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrician Printing and Publishing Company, Limited.—A contract, made 28th July, between this company of one part, and Sir John Pender and Sir James Anderson of the other part, cites that on the 23rd June the company entered into an agreement with Sir John Pender, Sir James Anderson and Louis Floersheim, called the vendors, for the purchase of (1) the business and property of the vendors as proprietors of a certain weekly journal entitled the *Electrician*, and as printers and publishers thereof, and as proprietors of certain other publications mentioned in the said agreement, and as general printers, publishers, advertising agents and otherwise upon certain premises, No. 1, Salisbury Court, Fleet Street; (2) the leasehold hereditaments, No. 1, Salisbury Court; (3) the plant, machinery, &c.; (4) the benefit of all contracts and engagements to which the vendors as carrying on such business should on the 1st July be entitled. The purchase consideration is £8,000 in fully paid shares of £10 each to be allotted as follows, viz.:—Sir John Pender, 300; Sir James Anderson, 100; Louis Floersheim, 150; John Denison Pender, 50; James Pender, 50; Kenneth Lockwood Morrison Anderson, 100; Louis Schott, 50. The agreement was duly filed on the 31st ult.

Electric Sewage Utilisation Company, Limited.—The statutory return of this company is made up to the 28th March. The nominal capital is £500,000 divided into 250,000 ordinary and 250,000 10 per cent. preference shares of £1 each. At the date of the return the only shares taken up were the seven subscribed for by the signatories to the memorandum of association.

Crompton & Co., Limited.—The registered office of this company is at Mansion House Chambers, 4, Queen Victoria Street. F. R. Reeves, secretary.

COMMENTS ON A CABLE COMPANY.

II.

WE learn from the published statements of the Direct United States Cable Company that they worked their cable until from its faulty condition they could do so no longer, and consequently were obliged to seek means to, if possible, repair it. We certainly cannot congratulate the company for selecting to carry out these repairs a rival manufacturer instead of the one who made and laid the cable.

In the repairs to submarine telegraph cables it is impossible to know at the time whether they have been successfully performed or otherwise. All that can be ascertained is that communication has been restored and that the insulation is satisfactory. The hauling and peeling the cable receives to accomplish this object may have caused incipient faults which time will sooner or later develop into sudden breaks or serious faults. This has happened with many a cable—in some cases quickly after the conclusion of the repairs; thus the remedy has proved worse than the disease.

The principle is the same in the manufacture and laying of cables, when we fear the germ of a serious disease is often engendered which does not fully develop until the cable has passed from the hands of the contractors and their responsibility is at an end.

How essential it is, therefore, that submarine telegraph companies should look more closely to their own interest. The type of cable suitable for manufacture and laying is not always the one designed for its *durability*, as it should be; the contractor, as a rule, hurries over his work to reach the desired goal, well knowing that 30 days after the laying is completed his responsibility will cease, and that the company who takes it from him is responsible for its future behaviour. Any man of business about to erect a large and important building would not think of starting it without judiciously selecting a site, consulting an architect, from whom he would get plans and estimates, and at last, when the preliminaries were arranged, appointing

superintendents to see that the work was properly accomplished.

Should not the important manufacture and laying of telegraph cables be conducted on the same principle? We think it will have to be so if good and sound cables are required.

The Atlantic cables are generally distinguished by the years in which they were laid. Thus we have the 65, 66, 69, 74 and others; but in most cases these cables have from time to time, owing to serious faults or total breaks, had several hundred knots of new cable inserted, so that in reality there is very little of the original cable left.

For instance, at the meeting of the Direct Company, we learn that the ship now engaged in endeavouring to repair their cable had taken 300 knots of new cable for that purpose;* therefore, unless it is known whether it be the old or the comparatively new section that is under repair, we are in doubt whether to applaud or censure, as the mere statement that the cable has been lifted and repaired in 2,200 fathoms may be misleading. But assuming that the original cable has been lifted from such a depth, it proves nothing as to what the length of life of a properly constructed and carefully laid cable should be.

The Anglo-American Company held their meeting a week after the Direct Company, and they then informed their shareholders that their Brest-St. Pierre cable was faulty in three places, that their repairing ship had repaired two of these faults, one of them being in 2,000 fathoms, and that they were only waiting on the banks of Newfoundland for a fog to lift to enable them to complete their work on that cable. Their cable is known as the 69, and is therefore six years *older* than that of the Direct Company; the tonnage, too, of the repairing ship belonging to the Anglo Company is much below that of the one engaged in the other repairs.

It must be humiliating to the system of submarine telegraphy to know that through causes which ought not to exist we possess no standard by which the true life of a good cable can be ascertained, although we believe that it would be much longer than is generally imagined. If the Direct Company is to continue in existence they should at once lay a new cable, which we hope their reserve fund will enable them to do, as they will find it difficult to raise the money for such a purpose in any other way, considering to what a very low ebb the property of Atlantic telegraph cable companies has fallen.

The fact is that the carrying power in that direction is overdone, and, therefore, if a few "lives" are taken, the better it will be for those who are left to divide the "pool."

THE GÜLCHER COMPANY.

UNDER the title of the Gülcher (New) Electric Light and Power Company, Limited, the company working the Gülcher patents for dynamos and arc lamps has been reconstructed, and has made a fresh start with prospects of future business of a most satisfactory kind. For the last few years, although doing a good and always increasing business, the company had to contend with impediments resulting from losses made in 1882 and 1883, soon after the formation of the company, and to have survived the time of trial through which all electrical companies at that period had to pass shows an amount of vitality well calculated, now that the outlook is so much improved, to enable the company to become as vigorous and successful as any. The company can point to some good work executed in the past, such as the installation at the Crystal Palace, consisting of 125 arcs of 2,000 C.P., which started in 1883, and the contract for which has just been renewed for four years longer. At the Royal Aquarium 45 arcs as well as incandescents have been running for three years, and at Olympia 68 arcs from the time of opening. The installation of 50 arcs of 3,000 C.P. at Sir W. G. Armstrong and Co's. was put up by the Gülcher Company three years ago, and an order for a 60 unit dynamo has recently been given by the same firm. Another important plant supplied by the company was that put in three years since at the mills of Messrs. Jonas Brook and Bros., at Huddersfield, for both arc and incandescent lighting, and many others of a similar kind might be mentioned as having been in existence for from three to four years. The company was the first to advocate the system of parallel arc lighting with a low tension current, and in the Gülcher dynamo and Gülcher arc lamp patents it possesses a property, the value of which is likely to increase as the advantages of this system become better appreciated. At the present time the manufacturing department of the business is fully employed, some important orders being in course of execution. The company has a contract with the City of Wellington, New Zealand, to supply plant for 500 incandescent lamps; another with Messrs. Arthur and Co., of Leeds, for 1,000 lamps, and dynamos for 1,500 lamps; another with the Meltham Spinning Company, Meltham, for 300 lamps, and dynamos for 400, as well as others for plants of a similar number of lamps or less, and a Scottish shipbuilding firm has given an order for engines and dynamos for torpedo boats. In addition to the work already actually in hand negotiations in progress indicate the probability of a very busy autumn and winter. The company makes a speciality of factory and colliery work and requirements of a similar character, and most of the large depositing dynamos for refining metals have been supplied by this company. We hope present indications will be verified and trust that the company is now fairly launched on a more profitable and prosperous career.

* Since repaired.

THE LIMIT TO AUTOMATIC TELEGRAPHIC TRANSMISSION.

By W. MOON.

ALTHOUGH it is not possible to say what will be the final speed of automatic telegraphic transmission, yet some idea may be formed of the relative importance of the different factors that oppose a further increase of the speed of transmission; and with certain stated conditions, it is possible to determine certain limiting speeds for each retarding factor, that it is physically impossible to exceed. But, of course, the speed thus calculated for each factor taken separately would be considerably beyond the limit produced by all the factors taken together. That is, beyond the highest speed that can be practically obtained.

Consider, for instance, the electro-magnetic inertia of the line wire and apparatus. If the total inductance of a circuit is 5 secohms, its resistance 1,000$^{\omega}$, the E.M.F. 50 volts, and the least current to which the apparatus will respond 5 milliamperes.

Then from the formula

$$C = \frac{E}{R}\left(1 - \varepsilon^{-t\frac{R}{L}}\right)$$

we get

$$t = \frac{L}{R}\log_{\varepsilon}\left(\frac{1}{1 - C\frac{R}{E}}\right).$$

$$t = \frac{5}{1000}\log_{\varepsilon}\left(\frac{1}{1 - \cdot 005\,\frac{1000}{50}}\right) = \cdot 00053$$

That is the time that will elapse before the current gains sufficient strength to actuate the apparatus will be ·00053 of a second. But a Wheatstone transmitter that makes $\frac{1}{\cdot 00053}$ reversals in a second would transmit

$\frac{1{\cdot}25}{{\cdot}00053}$ = 2,400 words a minute. And evidently this speed could not be obtained under the preceding conditions.

Again, suppose the inductance of a circuit is 5 secohms, its resistance 5,000$^{\omega}$, the E.M.F. of the battery 100 volts, and the least current to which the apparatus will respond is 5 milliamperes. The "t" = ·00029, or in this case it would be impossible to attain a speed of 4,350 words a minute. If, however, the E.M.F. in the second case had been the same as in the first case, the limiting speed would only be 1,900 words a minute. But these speeds are so much greater than the actual speeds attained, that it is evident that the inductance of the circuit is not the only factor in retarding the speeds of transmission.

Owing to the static capacity of the line, the formula

$$t = \frac{L}{R} \log \varepsilon \left(\frac{1}{1 - c \frac{R}{E}} \right)$$

gives a value of t much too small. The pulses of current are weakened in neutralising the static charge of the preceding current and recharging the line; and the diminished potential at the receiving end takes longer in overcoming the electro-magnetic inertia of the apparatus.

The following table of the inductance of telegraph apparatus may afford some idea of the actual retardation that takes place from the electro-magnetic reaction of the circuit.

Inductance in Secohms.

Large standard relay coils in series	3·26
" " " " in multiple arc... ...	·76
Small " " " in series	3·28
" " " " in multiple arc ...	·79
Large non-polarised relay, coils in series, tongue on cores	3·22
" " " coils in series, tongue away from cores ...	2·2
" " " coils in multiple arc, tongue on cores ...	·73
" " " coils in multiple arc, tongue away from cores	·54
Galvanometer coils in series	·22
" " in multiple arc	·05
A sounder coils without an armature	·45
" " armature resting on top stop ...	·9
" " " " on cores ...	2·16

To form some idea of the relation existing between the inductance and the dimension of the electromagnets, I wound four coils with number 30 wire to a resistance proportional to the size of their iron cores; and obtained the following results:—

Iron core	3 in.	long,	$\frac{3}{8}$	in.	diameter,	20$^{\omega}$	resistance, ·21 secohms.
"	4	"	$\frac{1}{2}$	"		47½$^{\omega}$	" ·88 "
"	5	"	$\frac{5}{8}$	"		92½$^{\omega}$	" 2·45 "
"	6	"	$\frac{3}{4}$	"		160$^{\omega}$	" 5·7 "

From these measurements it will be seen that the inductance of an electro-magnet varies nearly (but rather more than) as the resistance to which it is wound, that is, to the square of the length of the wire upon it.

In the case of similar electromagnets of different sizes the inductance would appear to vary nearly inversely as the square root of their dimensions, when they are wound to a resistance inversely proportional to their dimensions. Or the inductance varies nearly as, but rather more than, the (dimensions)$^{\frac{3}{2}}$ when the electromagnets are wound to the same resistance.

In differentially wound apparatus the inductance is the same when one of the coils only is in the circuit as when both coils are in multiple arc.

The two coils in series, of a differentially wound apparatus, always shows slightly more than four times the inductance of one of the coils only.

Although the large standard relay has only the same inductance as the smaller one, yet the pull of the coils upon the tongue exerted by the large relay is about three times that of the smaller one; hence the larger relay is the more efficient.

As regards the size and shape of the coils of a relay, it is obvious, for rapid working, that of a number of relays wound to equal resistances and fitted with tongues having the same mechanical inertia and friction at their pivots, that that relay is the best in which the quotient of the square of the pull of the coils on the tongue by the electro-magnetic inertia of its coils is a maximum.

It often happens that a relay will work at a higher speed with its coils in multiple arc than when they are in series. This is generally the case upon long lines where the pulses of current that reach the receiving station are more attenuated by the static capacity of the line. A relay wound to a low resistance, since it has a smaller electro-magnetic inertia, will acquire its magnetism at a more rapid rate than if it is wound to a high resistance. And although a relay with its coils in series will exert twice the pull upon its tongue as when its coils are in multiple arc, yet, since when the coils are in series the electro-magnetic inertia is four times as great as when they are in multiple arc, it sometimes happens that when the coils are in multiple arc they will acquire sufficient magnetism to actuate the tongue in a shorter time than when the coils are in series. Evidently there must exist for each circuit (when worked with a certain battery power) a particular resistance to which the relay may be wound so as to work at its highest speed. And if the resistance of the relay is higher than this particular resistance the speed is reduced by the electromagnet inertia being too great; and if the relay is wound to a lower resistance the speed is reduced by the pull upon the tongue being too small.

This particular resistance would, however, vary inversely as the E.M.F. of the battery used upon the circuit.

As the rate of transmission becomes greater the inertia of the tongue of the relay or Wheatstone receiver plays a more important part in retarding the speed. The time of a journey of the tongue of the relay may be given approximately by the formula

$$t = \sqrt{\frac{s\,\mathrm{I}}{2\,y\,p}} \qquad (2)$$

Where s is the play, I the inertia, and p the pull of the tongue. The values of s, I, and p may be conveniently taken at the contact points.

Suppose the inertia of the tongue is ·085 ounces, its pull $\frac{1}{6}$th ounce, its play $\frac{1}{1000}$th inch, then

$$t = \sqrt{\frac{{\cdot}001 \times {\cdot}085}{2 \times 32{\cdot}2 \times 12 \times {\cdot}16}} = \frac{1}{1230}\text{th second.}$$

So that in this case if the time that the tongue rested on the contact stop at each reversal was equal to the time of its journey across, then a speed of 770 words a minute could not be exceeded. And even if nearly the whole of the time was occupied by the tongue journeying to and fro, a speed of 1,540 words a minute could not be exceeded. Or, again, suppose that the time that elapses before the current reaches sufficient strength to move the tongue "·00081 second" is added to the time occupied in a journey of the tongue "·00053 seconds;" then we may safely say that a speed of 930 words a minute could not be attained.

The time of a journey of the tongue of the relay is not very accurately expressed by formula (2), since the accelerative force, p, would be proportional to the difference of the action of the coils upon the tongue and the friction at the pivots. And the resistance due to the friction at the pivots would itself be a function of the speed with which the tongue was moved.

But if the pull of the coils on the tongue with a constant current is known, and the least current to which the apparatus will respond is also known, a value of p may be assumed which is quite near enough for purposes of illustration.

Moreover, the time occupied by the tongue in travelling between the two stops may be easily measured by connecting the two stops together, and by putting a

battery and galvanometer in circuit between them and the tongue. Then the difference in the deflection of the galvanometer when the relay is at rest and when it is responding to rapid reversals, gives the proportionate time occupied by the tongue in travelling from one stop to the other; and if the speed of the reversals is known, the time occupied by each journey of the tongue can be calculated.

When a relay is responding to very rapid reversals, the time occupied by the tongue in travelling from one stop to the other is often much longer than the time it is in contact with the stops.

The size and shape of the tongue of the relay may be so adjusted as to make the speed at which it will work a maximum. And this is the case when the length of the aluminium contact maker and the length and size of the iron tongues are such that

$$\sqrt{\frac{l\,s}{p}}$$

is a minimum.

The pull that the coils of a relay exert upon its tongue is proportional to the E.M.F. of the battery used. The E.M.F. of the battery is limited at present by the destructive influence of high potentials upon the insulation of the covered wire portion of the circuit, and by the formation of arcs in the transmitting apparatus. Ultimately, however, the E.M.F. of the sending battery will doubtless be limited only by the heat generated by the current in the coils of the receiving apparatus.

The mutual induction between neighbouring circuits also limits the speed of automatic transmission. For no matter how sensitive the receiving apparatus may be, if the currents induced from a neighbouring circuit approach in strength the attenuated signals received from the distant station, the two circuits cannot be worked at the same time. The only practical method of combating mutual induction is to increase the resistance and battery power of each circuit. Thus the strength of the direct currents may be kept the same while induced currents are reduced in strength.

Apart from the attenuation of the currents at the receiving end of the circuit by the static capacity of the line, the received current's strength is also diminished by leakage, and wet weather will always be accompanied by a reduction of the speed of transmission.

Despite the earth wires attached to most telegraph poles, there is always a slight leakage from one wire to another. But these leakage currents seldom exceed a fraction of a milliampère in strength, and do not much more affect the working of the circuit than the tidal earth currents, to which they are about equal in strength, and with which they are often confounded.

LIGHTNING.

By S. A. VARLEY.

(*Continued from page* 122.)

I THINK it has been now fairly shown that what is termed self-induction is magnetic inertia, and that magnetic inertia in a conductor is manifested directly as the quantity of magnetic matter brought under the influence of the *whole* of the electricity set in motion *throughout* the conductor.

That for this reason a ribbon conductor has less self-induction (magnetic inertia) than a cylindrical one, and a straight cylindrical conductor has less inertia than the same conductor when formed into a solenoid, and, further, this solenoid has less inertia than the same solenoid when a bundle of iron wires is placed in its interior.

We know the conditions which favour the development of magnetism, and these conditions harmonise throughout with the conditions which are found to favour the production of the phenomena attributed to self-induction.

If self-induction were due to electrical inertia, as Prof. Lodge and others seem to believe, then it would be difficult to assign a reason why a ribbon conductor should not exhibit it in as great a degree as a cylindrical one.

The inertia of matter is directly as its weight, and electric conduction as the weight of the conductor multiplied by its length, the shape of the conductor (assuming it be of a uniform section) not influencing the conducting power in any way. Now if self-induction were due to electrical inertia, it might be fairly expected that it would so far harmonise with electric conduction and material inertia as not to be affected by the shape of the conductor; but grant, for the sake of argument, that the shape may have an influence, then the self-induction manifested should not be affected in any way, whether the conductor be in a straight length or formed into a solenoid. Now I have never actually tried whether a conductor in the form of a solenoid will exhibit the so-called self-inductive phenomena in a greater degree than the same conductor when straight, but I will venture to stake my reputation as an electrician that this will be found to be the case, and if it be so there can be no escaping from the conclusion that self-induction, as it is called, has its source in the inertia of magnetism, and is magnetic inertia pure and simple.

What is understood as the development of electricity is generally attributed to an internal movement in the conductor which sets in motion the electricity associated with matter throughout, the conductor energy being locally dissipated directly as the resistance of the conductor through which a given quantity of electricity is passing. I myself am strongly of opinion that electric conduction is atomic as distinguished from molecular movement. There are reasons that lead me to conclude that electricity and gravity are forces as distinctly separate from one another as the material elements with our present knowledge would seem to be, and therefore gravity and electricity are not *directly* convertible.

There are reasons also for believing chemical affinity and electrical attraction are one and the same thing and are concerned in the organisation of matter and the formation of the atoms into molecules. Cohesion and gravity, on the other hand, would appear to have their origin in a common principle and to deal with matter after it has been formed into molecules binding molecules together and attracting matter in the mass bodily.

Familiar as we seem to be with matter from constantly being brought into contact with it, we know really but little of its constitution; the same may be said of inertia, motion, force, and time, terms in constant use and the effects of which we come face to face with almost every moment of our lives.

If our scientific schools would only break fresh ground by making researches into the nature of such elementary principles as I have mentioned instead of devoting their lives to the microscopical measurement of data already known and constructing with the aid of the scientific mechanician more and more perfect measuring instruments, as if the end of science were measurement, then I venture to think our progress in the acquisition of *real* knowledge would be much more rapid than it is.

By far the greater part of the communications brought under the purview of the scientific societies are simply additional literature which often tend to confuse plain issues and by the very mass of elaboration and detail make the acquisition of scientific knowledge more and more difficult. What struck me most at that very interesting exhibition of the late loan collection of scientific apparatus, was the apparatus of Faraday and models of that of Ampère, the whole of which stood on two small tables and could have been reproduced for a cost of a few pounds.

The simple apparatus of Ampère and Faraday was surrounded by the costly accurate apparatus of modern times, the whole of which, if regarded from a purely scientific standpoint, had been chiefly designed to measure, and only to measure, the

work accomplished by men of the calibre of Faraday and Ampère.

All we know of motion is that it is relative to matter and that it involves at the very least two atoms, for there can be no such thing as motion in reference to absolute space. I have been disposed to regard motion as a combination of matter with external force or energy of some form, and inertia as the storage of the external force by matter that involves time an entity, we really know next to nothing of.

If the question be asked what is force, our scientific schools have a ready answer. They will tell us forces are modes of motions, and would seem to think we ought to be satisfied with such an answer, which is really no explanation whatever.

For my own part, when I have sat under a certain popular ritualistic scientific preacher or master of style, as he is commonly termed, and observe the very vestments in which he has dressed his experiments appear to have received more attention at his hands than the truths he professes to be so anxious to inculcate, I could not help my sense of the ridiculous being excited when I have heard him enlarge from his pulpit on the infallible rock on which science is based, and the breadth of view which distinguished his own particular school as contrasted with another school of thought for which he does not disguise his contempt, and I have been unable to resist smiling when he has afterwards given his audience to understand that the nature of force is well understood and explained by the statement that they are modes of motion.

Whoever it was who coined the phase "heat is a mode of motion," must, I always feel, have had a lively appreciation of the scientific uses of the imagination.

In a certain sense I confess this phrase may be regarded as involving a truism, seeing every act performed is associated with what we express by the word motion, and what we understand by the word force is largely concerned in bringing about such motion; but if we analyse the phrase, it will be found to be merely a string of words, and nothing more or less than the concealment of our ignorance by the assertion of a dogma, and let me point out what is, I think, not recognised as much as it should be, that all scientific phenomena, if traced back to first principles, will be found invariably to be based on observations of a something which is neither more or less than a dogmatic utterance, and would be correctly expressed by the words, thus saith nature, a phrase very similar to that which frequently occurs in the sacred writings.

Dogmas have their use undoubtedly, and the phrase, "heat is a mode of motion," shines with a reflected glory, simply because some of our most eminent scientists have been content to accept the dogma as a ralying point or flag, and it is the work they have accomplished fighting under this banner, and this work *only*, which has given a value to the phrase, much in the same way as that given to the tattered rag some distinguished regiment carries into battle, and around which men fight and die, and which in the end finds deservedly a resting place in our cathedrals, because it symbolises that which distinguishes men among men, and man as man from the greater part of creation.

I must ask your readers to forgive this digression, the only excuse for which I can plead being that it seemed to me to be wanted to be said. Professor Lodge has stated that electricity is not energy, but one of the vehicles by which it can be conveyed, and I have myself, on the whole, been disposed to adopt this view; but some years ago, as the outcome of reasoning on certain experiments, I formed a theory, of which I made a note, which regarded electricity as energy. I, however, put this theory aside, partly because I am so strongly impressed with the feebleness of the human intellect to grapple with the phenomena presented to our gaze by the world of mystery in which we dwell, and partly because, in my opinion, there is too great a tendency to theorise and speculate; but as I have been writing this article the theory I have referred to will keep obtruding itself, and as it now seems to me to harmonise with the general direction of thought of the present time, I propose to briefly describe it. At different periods of my life I have thought I had obtained evidence that time might be considered to be a force; the evidence collected has, however, broken down invariably on more mature reflection. But, although I am disposed now to think that time cannot in any proper sense of the term be regarded as a force, it seems to be certainly a connecting link between the forces, and to have an important influence on them—for example, if a given amount of energy in the form of force of low potential be brought to bear on a mass of matter suspended in space, the whole of the energy, with the exception of a percentage so small as to be negligible, will be absorbed by the matter and converted into motion of the mass; but if the same amount of energy in the shape of force of higher potential be applied, the percentage of energy not converted into bodily motion will no longer be negligible; and if this given amount of energy be brought to bear on the mass, in the form of force of much higher potential, nearly the whole of it will become converted into heat, and the motion now imparted to the mass will be the negligible quantity. We see from what has been above stated that time is capable of connnecting energy with matter in such a way as to determine whether it be simply transmitted or converted at once into local work.

Heat and energy are convertible terms, and there is one case, and *one only*, that I am aware of, where the energy appears to be converted directly into electricity, and that is in the thermo battery. The fact that electricity appeared to me to be produced in this instance in an altogether different way led me to try some experiments on the development of thermal currents, and the conclusions I came to harmonise with what I believe to the generally accepted view, that the conditions the most favourable for producing thermo electricity are those that favour a rapid absorption of heat and its rapid radiation through the thermopile, and there seemed to be no escaping from the conclusion, that in a thermopile we have an example of the direct conversion of energy into electricity, and if so, then electricity must be something more than a vehicle of energy and would appear to be a form of energy.

Now if we accept the dogma that heat is produced by an atomic bombardment producing in the matter bombarded atomic motion, it seemed to me electricity might differ from heat simply in being a still more rapid motion, and that thermo currents were produced in a somewhat analogous way to that which occurs in a water ram where energy of low potential becomes converted into energy of a higher potential at the cost of a somewhat wasteful expenditure of energy.

Assuming the views I now venture to promulgate to be correct, and that electricity differs only from heat in being a more rapid atomic motion than the potential or energy of a current would be directly as its rate of motion, and we should have a simple explanation of what I believe to be the fact, that a lightning discharge cleaving its way through a space, it may be, of more than a mile of air, occupies no more time than the spark which discharges a Leyden jar.

The production of heat by electricity would be also accounted for in a natural manner, as when the rate of motion was retarded by resistance it would assume the form of heat, and the retardation would be the measure of the energy expended in breaking down such resistance, whether it be a conducting wire of small sectional area, a glow lamp or electric arc, or a space of air.

I would further point out the theory now propounded which has been gradually evolved out of reasoning upon experimental observations, and which has forced itself unbidden on my attention, seems to me to link together in one continuous train or natural order of sequence the data already known in connection with the action of gravity, the conversion of motion into heat, the development of electricity, and the transmission of energy by means of the dynamo. For example, when a stone falls from a height energy is imparted to it by gravity combined with time, such

energy being a function of the weight of the stone multiplied by the time gravity has been free to act upon it.

When the stone becomes suddenly arrested the energy of motion acquired is given out in a much smaller interval of time than that consumed in its production, and it becomes converted into internal motion or heat, a more refined form of energy and of a higher potential, using the term potential to express rate of motion, and this more refined or purer form of energy, when it is arrested by coming into contact with magnetic inertia, becomes converted into electrical or still more rapid motion, the rate of motion of the electric atoms being determined by the amount of energy arrested and the resistance of the conductor through which the electricity is transmitted.

Having now launched my little theory, and given the reasons for the faith that is in me, I leave it to others to deal with; it may be to explode, to put it aside, or perhaps to ignore altogether.

(To be continued.)

ELECTRIC LIGHTING AT THE EXETER ASYLUM.

A REPORT was made to the Exeter Town Council at their last meeting to the effect that the first cost of lighting the local asylum by electricity was £2,160 and the cost per annum £118. Under the contract Messrs. Woodhouse and Rawson were to supply storage batteries capable of maintaining 100 lamps of 16 C.P. for 14 hours without running the engine and dynamo. On the completion of the installation Mr. Massey, electrical engineer, reported that the storage batteries would run 100 Woodhouse and Rawson's lamps the specified time, but no other lamps then in use. Subsequently an injunction was granted against the use of Messrs. Woodhouse and Rawson's lamps as being an infringement of the Edison-Swan patent, and upon the lamps being changed it was discovered that the storage batteries would run 100 Edison-Swan lamps for 9 hours only. The Committee of the Asylum, having called upon the contractors to increase the power of the storage batteries, were met by the reply that they were advised that as the contract was for the erection of specified apparatus to the satisfaction of the architect they were not bound to provide additional storage batteries, those erected having been certified as complete and as having answered the test. They thought it was unfair to ask them to put in new cells, but they were willing to meet the Council to a small extent. It was explained that since this communication was received Mr. Justice Kay had decided against the monopoly claimed by the Edison-Swan Company, and the report was then adopted.

CITY NOTES, REPORTS, MEETINGS, &c.

National Telephone Company, Limited.

THE eighth annual meeting of this company was held last Saturday at the offices, 162A, Queen Victoria Street, E.C. The report of the directors submitted to the meeting was published in the REVIEW last week.

Mr. Wm. B. Campbell, the secretary, having read the notice convening the meeting,

The Chairman said: Gentlemen, the report contains within itself all that is necessary for you to know of the affairs of the company. You will see that the gross revenue reached on June 30th last was £109,572 12s. 7d., and that the increase for the year was £17,235 10s. 3d. I will ask your attention to the abstract of accounts; there you will see that the first three columns are headed differently to the heading used in former abstracts. The heading in those was "gross revenue;" that was to a certain extent misleading, because some people thought it meant the gross revenue entered in the accounts for the year, whereas it is the revenue reached by June 30th; and it is divided in the present abstract into two headings—annual rentals and sundries, and fee messages. You will see that the fee message revenue is steadily growing, and I thought it would be interesting to you to watch the development of this source of profit. The trunk pole lines are now 842 miles, an increase of 199 miles since last year; and the wire they carry is now 2,509 miles, an increase of 590 since last year. There is also an increase of 26 in the number of exchanges, and of 1,470 in the number of lines, the present number of lines being 9,324. I now call your attention to the list of our centres on the second page. You will see the large number of towns that are grouped together and have communication with each other through the instrumentality of the trunk system. By next year we shall have a considerable increase in the number of towns so connected, and by the middle of September Sheffield and Birmingham will be in telephonic connection, which will combine the Midland district with Nottingham and carry a trunk line from Birmingham through the Potteries to the frontier of the Lancashire and Cheshire Company's system, and they will meet us there. We shall then have trunk communication in almost a straight line from Birmingham to Manchester and the whole Lancashire system. This will give us the advantage when London and Birmingham are telephonically connected of a short connection between Manchester and London. London also will be connected with Nottingham and Yorkshire through Birmingham. I now call your attention to one feature in the capital account, that is that £70,700 out of £75,000 debenture bonds have been converted into debenture stock. £60,900 of the debenture bonds were at 6 per cent. interest and £14,100 at 5 per cent. The debenture stock has been issued at 4½ per cent., thus greatly diminishing the interest account. I wish now to call your attention to the position we occupied before November 29th, 1884, and if you will look at the map you will see the boundary of our districts marked in red. You will see in red several small spots; these represent telephonic oases in a huge barren district, for they were the only areas in which we were allowed to exploit the telephone. We were not allowed to connect town and town; and had the system then in vogue continued it would have been utterly impossible to make the progress which I have described to-day, and to cover the country with exchanges and trunk wires. Mr. Fawcett, a liberal and large-minded statesman, presided over the Post Office, and he, in the interest of the public, gave us new licences, enabling the lines in all directions to connect town and town, and rendered possible the development at which we have arrived to-day. Had it not been for this, the position of the telephone in this country, which leads the van in enterprise, would have been absolutely disgraceful. With reference to amalgamation I have only to confirm the words used by Mr. Brand when addressing his shareholders. He mentions as one of the difficulties in the way of amalgamation the difference of opinion that may arise as to the valuation of the prospects of future development. I do not think that when fair-minded men approach each other with a view to obtaining a given result difficulties are allowed permanently to stand in the way—the means are generally found to overcome them; but I will say this much, as regards the National Telephone Company, that we shall have to be specially guarded against giving capital for prospective improvements in other companies, the dividends upon which may have to be paid out of the solid earnings of the National Telephone Company. I do not apprehend, however, that the necessity of taking care of ourselves upon this point will stand in the way or be an important factor in our negotiations. It may not be unimportant, when we are so much in contact with a great public department as we are with the Post Office, that it should be known to our shareholders that our relations with that department continue to be of the same friendly character as hitherto. The chairman concluded by moving the adoption of the report.

Colonel Harrison seconded the motion, and it was carried unanimously.

The Chairman moved the payment of dividends for the half-year at the rate of 6 per cent. on the first preference shares and on the amount of the second preference capital paid up, and of 5 per cent. upon the ordinary capital. This was seconded and agreed to.

Mr. John Bruce, of Edinburgh, and Mr. Jeremiah Garnett, of Manchester, were re-elected directors; the auditors, Messrs. Quilter, Welton & Co., were re-appointed; and a vote of thanks to the chairman, the directors, and the secretary having been passed, the proceedings terminated.

Cuba Submarine Telegraph Company, Limited.

THE thirty-fourth ordinary general meeting of this company was held at the offices, 61, Old Broad Street, on Wednesday, Mr. Joaquin de Mancha, the Chairman, presiding.

Mr. Jas. Scott, the secretary, having read the notice convening the meeting,

The Chairman said it was again his pleasure and duty to meet the shareholders with a very favourable report. The increase in the revenue was going on very satisfactorily. There was an increase of nearly 10 per cent. in the number of messages, and the income had increased in the same proportion. The expenses were very much the same as before. Although they had had to repair the cable once or twice they were able to show a very good result. The only extra charge was an insignificant one of £180 to the Spanish Government for conveyance of messages by land whilst their cable was being repaired. The accounts showed that after paying all expenses, which amounted to £6,879, £17,395 were left to be disposed of. From that would be paid the usual dividend of 10 per cent. on the preference shares, and a dividend of 9 per cent. on the ordinary shares. He thought, taking everything into account, they could not but be satisfied with such a result, and he hoped it would continue for many years to come. The cables were all in good working order, but as their old cable had been laid for so many years it might some day require to be thoroughly overhauled. That would entail a certain expense, to meet which they were careful to make their reserve fund as strong as possible. He was sure that it was for the benefit of the company that the reserve fund should be strong, so that should any emergency arise they would be prepared to meet it without interfering with the dividends. He was glad to say that the half month's traffic since the making up of the accounts still showed an increase. They had

received 570 more messages than in the corresponding period of last year. He moved, in conclusion, that the report and accounts be received and adopted.

Mr. Low seconded.

Mr. Williams remarked that the Eastern and Eastern Extension Companies invested their reserve in debenture stock. Why did not this company also do so?

The Chairman replied that debenture stock did not give quite so much as the banks in which they had placed their money. They got in one instance 5 per cent., and in others 4 and 4½ per cent.

The resolution for the adoption of the report was put and carried unanimously.

The Chairman then moved the declaration of the dividends of 10 per cent. on the preference shares, subject to income tax, and 9 per cent., free of income tax, on the ordinary shares.

Mr. Low seconded, and the motion was agreed to.

Mr. Horatio J. Perry, the retiring director, and Mr. Thomas Greenwood, the auditor, were re-elected, and the meeting closed with more than usually cordial votes of thanks to the chairman and directors, Mr. Scott, the secretary, Mr. Keith, the engineer, and the staff generally.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of July was 3,850, estimated to produce £5,100, against 3,280 messages, producing £2,607 in the corresponding month of last year. The receipts for the month of April, estimated at £3,700, realised £3,705.

The Great Northern Telegraph Company, Limited. The receipts for July, 1888, £24,000; January 1st to 31st July, 1888, £155,000; corresponding months, 1887, £150,529; and of 1886, £147,560.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of July, 1888, amounted to £35,233, compared with £38,520 in the corresponding period of 1887.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of July were £1,518, against £1,538 in the corresponding period of last year.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending July 31st are £4,550.

The Eastern Telegraph Company, Limited. The receipts for July, 1888, amounted to £48,735, compared with £45,805 in the corresponding month last year.

NEW PATENTS—1888.

10887. "Improvements in electric cartridges and primers." S. A. DAY. Dated July 27.

10904. "Improvements in electric batteries." R. SAUERWALD. Dated July 28.

10929. "Improvements in magneto-electric generators and appliances for use in connection therewith." E. COX-WALKER and A. A. C. SWINTON. Dated July 28.

10941. "Improvements in the arrangements for the lighting of railway trains by electricity." I. A. TIMMIS. Dated July 28.

10945. "An improved cut-out for electric circuits." W. H. AKESTER and G. HOPKINS. Dated July 28.

10952. "Improvements in dynamo-electric machines." L. S. M. PYKE and H. T. BARNETT. Dated July 28.

10954. "Improvements in or connected with dynamo-electric machines." E. H. GEIST. Dated July 28. (*Complete.*)

10956. "An electrical lighting apparatus for medical and surgical purposes." C. SMITH. (Communicated by R. Blaensdorf, Nachfolger, Frankfort-on-Maine.) Dated July 28.

10982. "Improvements in electric battery cells and combinations of same for electric lighting, power, signalling purposes, firing torpedos, &c." T. PEASE. Dated July 30.

11019. "Improvements in electric bells." W. MOSELEY. Dated July 30.

11050. "The cure of toothache by a voltaic couple." J. PARKINSON, S. FAWCETT, and C. F. PARKINSON. Dated July 31.

11065. "Improvements in or relating to apparatus for regulating the brilliancy at which lamps included in the secondary circuits of induction coils or electric converters may be caused to burn." W. P. THOMPSON. (Communicated by G. Westinghouse, Jun., United States.) Dated July 31. (*Complete.*)

11082. "An improved mode of an apparatus for transmitting electrically autographic messages, signs, and markings." P. A. NEWTON. (Communicated by E. Gray, United States.) Dated July 31. (*Complete.*)

11092. "An improved combination of a steam engine having a vibratory and partly circular motion, with a dynamo-electric machine." G. M. CAPELL and J. S. RAWORTH. Dated July 31. (*Complete.*)

11100. "Improvements in permanent way for vehicles propelled by electricity." J. KINCAID. Dated July 31.

11106. "Improvements in electrical signalling apparatus." H. H. LAKE. (Communicated by E. Davis and E. B. Welch, United States.) Dated July 31.

11108. "Improvements in electric conductors or cables, and in means for preventing disruptive discharges therefrom." P. M. JUSTICE. (Communicated by E. G. Acheson, United States.) Dated July 31. (*Complete.*)

11174. "Improvements in and connected with the method of and apparatus for electrically lighting railway trains." T. PARKER. Dated August 2.

11182. "Motive power for driving electric and other machinery." F. S. HARWOOD and H. G. CHEESMAN. Dated August 2.

11184. "Improvements relating to electric arc lamps." F. TEAGUE and F. E. TEAGUE. Dated August 2.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

8641. "Improved system and means to be used in the supply or distribution and control of electricity for lighting or other purposes." H. EDMUNDS. Dated June 15. 1s. 1d. Claims:—1. In a system for charging and discharging secondary batteries or electrical accumulators, the use of means whereby (without the employment of duplicate sets of batteries) the batteries which supply electricity to the discharge mains are automatically put into connection with the charging and discharging mains in sections, at stated intervals of time, in such a manner that (1) no portion of the battery is in connection with both the charging and discharging circuits at one time, (2) the charging circuit is never broken, (3) the discharging circuit is never interrupted nor the pressure therein made to fluctuate, nor any portion of the batteries short-circuited even momentarily during the process. 2. In an electricity distributor working under the conditions mentioned in claim 1., the combinations of a contact-maker or commutator with timekeeper for periodically effecting changes in the circuit of a battery of secondary cells or accumulators divided into sections or groups enabling them in turn to receive or discharge current in connection with an automatic device for controlling the amount of current, the battery may so receive a discharge combined with a connecting mechanism which registers the number of such changes as may be required for metering purposes. 3. In a system for charging and discharging secondary batteries, the employment of means substantially as herein described and illustrated for regulating the charging and discharging of the batteries so as to maintain uniform pressure in the discharging circuit. 4. The mode of effecting the transference of batteries to and from the charging and discharging circuits represented by the cycle of operations delineated. 5. The mode of effecting the transference of batteries to and from the charging and discharging circuits by the use of resistance or extra batteries which are introduced during the process of changing, substantially as described. 6. A meter for measuring electrical supply or discharge, constructed substantially as described and illustrated. 7. An apparatus for preventing overcharge or over-discharge of secondary batteries, and generally for indicating and controlling differentially the action of two electrical currents, substantially as described and illustrated. 8. The general arrangement and combination of electric circuits and devices, substantially as described and illustrated, constituting a system of electrical distribution, or part of such a system, substantially as and for the purpose described.

8701. "Improvements in and relating to the production and application of electric energy for lighting and other purposes." J. ROSS. Dated June 16. 8d. The inventor mounts two commutators on the same axis or spindle which may be driven at a high speed by a small motor, or from the armature shaft of a dynamo-electric generator, or the commutators may be mounted or coupled on to the armature shaft. These commutators are each placed in circuit with a dynamo-electric machine, battery or other generator of electric energy which supplies a direct or continuous current. The commutators are also each placed in circuit with the inner and outer wires respectively of an induction coil or coils through which alternating currents of electric energy are made to pass.

9191. "Improvements in type printing telegraphs." G. A. SCOTT. Dated June 28. 1s. 6d. Consists in part of improvements in the receiving or printing instruments of printing telegraphs worked with three or more wires, or on synchronous systems, or on synchronous multiplex systems, which improvements consist essentially of a series of magnets or solenoids having their armatures or cores so arranged relatively to a flexible connection or flexible connections secured to or engaged with the type wheel, or the shaft thereof, or relatively to mechanism connected to or engaged with the type wheel or its shaft, that the part of the wheel bearing any required letter or character may be turned or permitted to turn round to the printing point by opening or closing the circuit of a battery or batteries through the coil or coils of one or more, or all, of the said magnets or solenoids. Consists further of improvements in the arrangement of the keys and contacts of transmitting instruments of printing telegraphs worked on systems such as that known as the Baudot system, which improvements are capable of use in connection with receiving or printing instruments provided with the improvements described. The claims are 21 in number.

9843. "Compensating electric measuring instruments for temperature." W. T. GOOLDEN and S. EVERSHED. Dated July 13. 8d. The inventors wind the coil of a voltmeter or a pressure-regulating device, partly with a wire having a small coefficient and partly with a compensating wire having a large coefficient;

the latter wire being coupled in shunt to a portion of the former wire in such a way as to cause the current to flow in opposite directions in the two wires. The resultant magnetic field of the combination coil will then be equal to the difference of the fields due to the two wires, and, by observing certain proportions between the resistances and number of turns of the two wires and the resistance of the shunted portion of the wire having the small coefficient, this difference may be made constant for constant pressure on the terminals of the coil throughout a large range of temperature. In a potentiometer the pressure on the terminals when the current in the standard-cell circuit is zero is equal to the product of the electromotive force of the cell, and the ratio of the resistances of the two coils or wires used; and the inventors make one or both coils or wires partly of wire having a small coefficient and partly of wire having a large coefficient, joined in series or in parallel to the first wire, of such resistances as to give the ratio as a whole a virtual coefficient equal, but of opposite sign, to that of the standard cell, so that the indications of the potentiometer are not affected by temperature.

10071. "Improved fittings for electric incandescence lamps." W. B. SAYERS and W. H. STURGE. Dated July 19. 8d. Consists of a claw with three or four radiating arms supporting a reflector, which may be of silvered glass, opal, polished, painted or enamelled metal or other suitable material. One arm of the above-named claw is extended to form a collar through which an adjustable tube passes, which latter is bent round to carry the lamp holder so that the filament of the lamp is approximately parallel with the plane of the rim of the reflector. The collar is fitted with a screw to clamp the tube in any desired position, so that the lamp may be secured in the best relative position to the reflector. The claw which supports the reflector may be joined to the supporting tube or rod by a universal joint of any of the well known forms. The conducting wires or leads pass through the bent tube, and may either be carried along the supporting rod or tube by means of eyelets fixed thereto, or may pass into the tube through a hole or holes in the sides. The claims are 7 in number.

10233. "A novel combined electrical vapour bath." M. MAITLAND. Dated July 21. 8d. The inventor adapts by means of wires and suitable connections an ordinary induction coil and constant battery to the vapour bath, one wire from the secondary coil of said induction coil being attached to one or both of the metal bearings fixed on the interior sides of the bath, the other wire being attached by means of a screw connection to a metallic foot pan in the interior of the bath. The metal bearings above referred to are devised for the purpose of holding a metal rod or bar in such a position and at such a height in the interior of the bath as shall be conducive to the comfort of the patient under treatment, or said bearing may be formed with a graduated incline to suit patients of different statures. The induction coil (or if it is preferred to employ a constant battery alone) is provided with a graduated switch, by means of which the amount of current to be used is proportioned to the requirements of the special ailment to be treated, and according to the physical strength of the patient under treatment. The claims are 8 in number.

10606. "Improvements relating to the distribution, storage, and regulation of electric currents." L. GERARD. Dated July 30. 11d. Consists chiefly in a new arrangement of secondary batteries, circuits, and regulating appliances which will allow the simultaneous charging with currents of high electromotive force, and discharging with currents of low electromotive force. The claims are 3 in number.

10748. "Improvements in portable batteries for the production of electric light." A. SCHANSCHIEFF. Dated August 4. 8d. Claims:—1. A lamp battery, substantially as described, consisting of a vessel divided by partitions into cells; a cover in one or more parts carrying the elements and a glow lamp; a stem passing through the centre of the cover and connecting it with the vessel; and a nut or fastening on the stem holding the cover in place and closing the battery. 2. A lamp battery, substantially as described, consisting of a vessel divided by partitions into cells; a cover in one or more parts faced on its inner side with India-rubber closing the vessel; battery elements attached to the cover; connecting wires between the elements and to the battery terminals laid in grooves in the cover and between it and the India-rubber face. 3. The method, substantially as described, of connecting the zinc elements by forming a screw-thread upon them and screwing them into nuts inserted into the cover of the battery. 4. A lamp battery with telescope container or vessel, substantially as described. 5. Apparatus, substantially as described and represented by the drawings.

CORRESPONDENCE.

Galvanic Belt Quackery.

My attention has been called to a letter in your issue of July 27th from a Mr. J. Jerritt, wherein he quotes a statement of mine published *some years ago* in *Health*, relative to a belt *then* made by the Medical Battery Company. Mr. Jerritt should have made some enquiry of me before rashly rushing to the conclusion that I had recommended a belt of bogus nature. The belt in question was one made by the Medical Battery Company, and duly tested by my friend Mr. Lant Carpenter. His report bore that the belt was a genuine electrical appliance, and therefore it was noticed in the pages of this Journal. Whether the belt in question is still manufactured and sold by the Medical Battery Company I know not, but I wish it distinctly to be understood that the remarks quoted by Mr. Jerritt refer to the appliance which was examined by Mr. Carpenter. I have on no occasion whatever made any statement expressing approval of belts which are not genuine electrical appliances, and if Mr. Jerritt had been a regular reader of *Health*, he would have found ample testimony in its pages to the latter fact.

Andrew Wilson,

London, E.C., *August 6th*, 1888.

I send herewith a copy of a letter which has been forwarded to me by an acquaintance of mine who received the epistle from the President of the British Association of Medical Electricians. You will kindly observe that it is a case of "sterility" similar to that mentioned in my communication published in the ELECTRICAL REVIEW dated July 27th.

The worthy president's advice was, as usual, given gratuitously, the usual consultation form being returned to him. It might perhaps be as well to quote the questions contained in this so-called consultation form. I believe an identical form is sent to all applicants, old maids, women, and children, whether suffering from sore feet or heart disease—"Married or single," "Age," "Nature of illness," "Cause of symptoms," "Under what treatment," "General health," "Abstainer or otherwise," and last but not least, "Measurement round waist, hips and chest, next the skin." Would it not save the learned president a lot of unnecessary trouble and expense if to these questions the following were added: "Rich or poor," "Intellect perfect or impaired?" Now, sir, I ask you how many men in existence, not being qualified practitioners, would have the cunning impertinence, the audacity to pen such a letter as the one I now submit for your inspection. It is indeed beyond my comprehension to understand how or why it is that the medical profession stand quietly by and allow all this! Let this big advertiser treat law as he does medicine, and in the twinkling of a sheep's tail he would be suppressed and sent to Holloway for a few months to rest his marvellous inventive powers.

In a letter I have just received from Mr. Parkes he states;—"I called on Dr. (?) Leeson, whose consulting room was on the top of a flight of stairs. I explained that I had come, in accordance with the invitation of the circular, to see his arrangements, &c., for electro-massage, mentioning a case I had of paraplegia, likely to become a patient if I was satisfied with the arrangement, &c. Dr. L. seemed a little disconcerted by my desire to see his system, and put me off by saying, 'I am *very* sorry, but *all* my rooms are full of patients just now,' and on my asking if he could appoint a time for me to come when less busy, he was sorry to say he couldn't. My opinion at the time," continues Mr. Parkes, "and is now, that the only operating room in connection with the department was an ordinary three-fold screen on the same landing. I certainly saw through the joint in the screen a semi-nude figure pass several times during my consultation. His terms for *ordinary* treatment were 21s. per visit; but he strongly advised me to recommend to my patient *first* a 5-guinea 'electropathic.' For 8 guineas he had a very strong one, and, for a case like the one I mentioned, a battery in addition to attach to belt would be advisable. On my asking him (feigning ignorance) the best way to apply the battery, and duration of dose, &c., he said, 'Oh, about five minutes every morning! The best guide as to amount is to stop the current as soon as it pricks' (very professional, I've no doubt, you will say).

He pointed out that I could draw my fees also from the patient at the time of using the above, and if they were not sufficient, I could then send them to 52, Oxford Street, for further spiral belts or treatment. Selling belts was evidently what this gentleman was most used to." I have Mr. Parkes's permission to make use of the foregoing, and I need hardly mention that I am only too delighted to send it to you for publication.

After perusing Mr. Parkes's statement, I feel that I truly require a "London Galvanic Generator" to support my shattered nerves.

The electropathic treatment will, I have no hesitation in stating, cure roaring in horses, and I've every belief Mr. Parr, who is trying the experiment, will meet with success. It has for years past, so advertisements tell us, cured roaring donkeys; why shouldn't it have the same effect on horses.

Did your correspondent, Mr. Browne, notice whether it was a hen or cock sparrow? I see a Mr. Sparrow derived much benefit from the same treatment. It would indeed be strange if Mr. Browne's patient was Mr. Sparrow's better half.

J. Jerritt.

August 6th, 1888.

[Confirmation strong enough to convince all but the absolutely ignorant or the determinedly prejudiced is continually being supplied that the concern to which our correspondent refers is a trading business of a meretricious kind, professing philanthropic principles in order the more readily to exert a baleful attraction upon credulous simplicity.—EDS. ELEC. REV.]

Telegraph Survey and Construction.

Referring to the letter in the REVIEW of 3rd inst., signed J. McDonald.

From the style of the letter, and seeing it does not bear the designation and address of the writer, and seeing further that the object evidently is to obstruct rather than promote fair and open comparison and discussion, I have simply to refer Mr. McDonald to my letter in the same issue of the REVIEW, and to request him to carefully observe what I therein said.

Arthur E. Gilbert.

August 6th, 1888.

[Our correspondent's address was omitted in accordance with our usual practice.—EDS. ELEC. REV.]

Electrical Workman's Club.

I am quite at a loss to understand Mr. H. Raison's letter in last week's issue, as he describes himself as an electrical workman, and fails to see any benefit attached to amalgamation. If he were a bargeman or a greengrocer, where would his electrical knowledge come in to enable him to earn the munificent sum of 20s. per week? He says most of the work is done in an unscientific manner, science and skill are unnecessary attainments; but he is labouring under a delusion. As an electrical workman, he must know that there are many gentlemen in the profession who have to hand in a certificate to show that the work has been done in a scientific manner. Does he, as a sensible man, think that gentlemen like Mr. Musgrave Heaphy and other well-known electricians put their reputation at stake to suit the requirements of a *bargeman* or a greengrocer. Such men as Mr. Raison are only guided by those who have their own object in *view*, and that is to crush the poor British workman and cause rates and taxes to be double what they would be if workmen were receiving value for their labour. As to the cheerful future, there are many men who have made handsome fortunes in their time and been compelled to wind up their days in the union or a lunatic asylum through misfortune. It would not do for us all to see our future; we should almost be afraid that we were growing old and turning grey to enable masters to brand us old bargemen and greengrocers.

W. Howard.

August 8th, 1888.

Comparing Very Unequal Capacities.

Kindly permit me to remark, as a supplement to my last letter on this subject, that a complete solution may be obtained from the equation for e_n in place of the approximation given.

If we write

$$e_n = \frac{E\{(K+k)^n - k^n\}}{(K+k)^n}$$

we can easily obtain

$$\left(\frac{K}{k}+1\right)^n = \frac{E}{E-e_n}.$$

J. Pigg.

August 6th, 1888.

Electric Locomotion.

It was with feelings of gratification that I read Mr. Reckenzaun's encouraging letter in your issue of July 13th, but at the same time I cannot help feeling surprised that he should so far have misunderstood the meaning and object of my words. I am not accustomed to writing articles, nor do I feel any particular inclination for doing so, therefore shall do my utmost to avoid being drawn into a controversy; in that field I humbly acknowledge Mr. Reckenzaun's superiority.

When writing I avoided criticising any particular system of locomotion, but simply endeavoured to impress upon the reader the necessity of guarding against weakness in the construction of either part, so that the originality and advantages of an invention may stand a fair chance of being tested.

I am asked to make known where I have met with failures or mishaps. It is true that I wrote about "the mistakes which we have all experienced." In including myself I felt more freedom in writing, but I was wrong in doing so, and as I am asked for it I must, under the circumstances, make an exception, for, as far as mechanical arrangements are concerned, I have met with no failure whatever. The engines for eight months have carried on regular service at Stratford, and have only stopped running during the erection of a new station, which will enable the whole line to be worked electrically.

If I have not made mistakes it is because the difficulties and failures of others have been my special study, and Mr. Reckenzaun will doubtless remember that it was under his able guidance that I made my first steps in electric traction some years ago, and nobody can appreciate the value of it more than myself.

As I passed no criticism on any other system, I think Mr. Reckenzaun has shown bad taste in throwing a bait, at which I feel no inclination to bite, as the question would only be likely to lead to endless discussion of no real benefit to any one.

While we in this country are wrangling over figures our friends, *d'outre-mer*, are doing good work. Those figures, by which electricians appear so anxious to prove one system to be better and cheaper than another, are, in reality, but *lettres mortes*. After the experience I have had I can positively state that tramway directors laugh in their sleeves at this sort of thing, and unless a system has been demonstrated by actual running for a certain period, and the exact cost placed beyond the shadow of a doubt, no figures as to probable cost will induce them to adopt one system or another.

The Elieson Company have for eight months run two cars without interruption, and during that time carried several hundred thousand passengers running 41,240 miles; but with two cars the precise cost could not be ascertained.

A new station is now in course of building, so that the line may be worked entirely by seven or eight cars.

This is the sole means by which the knowledge of the actual cost as compared with horse haulage can be arrived at. If any other system can run more cheaply, so much the better; but to satisfy tramway companies this must be indisputably proved.

Wonderful results may be obtained by running a car round and round a certain track to ascertain the number of miles it is able to travel with one charge, but these

results may be very deceiving; let the same car be put to work on a public road, in all probability these figures will vanish. I am sure that Mr. Reckenzaun will agree with me that something more tangible must be done to influence tramway directors (at least in this country) in favour of electricity.

It may be very interesting from a scientific point of view to know the roughness and undulations at the bottom of the sea, but such knowledge will not prevent a ship afloat upon its surface sinking and going to the bottom. It would be more to the point to turn our minds to find the best method to construct the ship. Neither is it by treating the motive power of electricity with so many figures and decimals that we shall send electric trains to work the Underground Railway; nor by taking measurements to record the difference every passenger in stepping in or out a car will register on an instrument, that we convey a practical idea to tramway directors and so persuade them ultimately to open their tracks to us and discard their horses. So long as these experiments are intended to enrich scientific literature they are, of course, invaluable; but at the present time it seems as if they were directed towards a commercial end, under which circumstances they do more harm than good.

The answers to the questions in Mr. Reckenzaun's letter have all at different times been published in the ELECTRICAL REVIEW and other papers, with the exception of the ninth question; of course this was the particular point aimed at in Mr. Reckenzaun's letter. Although I am somewhat reluctant to throw myself back to a period of bitter experience, I feel somehow compelled to give details. When we began our regular running on the 6th of June, 1887, we were after 10 days compelled to stop on account of the breaking of the armature connections, some of the engines leaving the depôt and returning with a third of the armature cut out of circuit. This difficulty was overcome and running resumed, and no further hindrances were experienced up till the 8th of December, at which date I was compelled to leave England on account of my health. Up to that time not a single accumulator plate had had to be replaced; the running was kept up regularly and things went on very satisfactorily.

During my absence a great desire was felt to improve matters—who would not be desirous of doing so? Fate had ordained the accumulator department to undergo improvements. It was found that the accumulators when sealed up could not be attended to so quickly and so it was decided to remove all the lids; this operation forcibly necessitated the withdrawal of a third of the liquid in order to avoid splashing, but notwithstanding this the engines were smothered in acid, which greatly interfered with their running. Then it was necessary to have recourse to another *grand moyen* and a very luminous idea suggested itself, which was to overcome the difficulty of splashing—the top part of the accumulators was filled up with sawdust. This undoubtedly stopped the splashing to a certain degree, but at the same time it checked the electrical action: 1. By withdrawing part of the liquid, which diminished the storage capacity; 2. By adding the sawdust which dropped between the plates, causing the internal resistance to be enormous; the E.M.F. dropped and the discharge while starting or running up a hill was simply frightful. The engines as a natural consequence, returned every time late and almost completely discharged. The regular charging current used to be from 30 to 35 ampères; under these circumstances it was difficult to get a current into the accumulators, so the charge was increased to 75 ampères. It will be easily understood what havoc was going on among the accumulators, half empty, choked up with sawdust and with such a rate of charge, and in what state I found the department on my return on the 5th of February, when 1,100 plates had been discarded in the course of two months. All this may appear incredible, but nevertheless they are facts, and if for a time the accumulators were subjected to such murderous treatment, this certainly ought not to stand as against their particular merit for electric locomotion, for which purpose they have specially been designed. It is even marvellous that under such conditions the engines have performed any work at all.

At that time I was novice enough to seek to know on whom the responsibility of such an act of vandalism rested. The man in charge of the depôt was dismissed, but the responsibility was certainly not his alone. But I knew too late that I ought not to have let my investigation on the matter go any further. On account of this and other matters I thought right to interfere in, I was *ipso facto* struck off the books as consulting engineer to the company.

I must not dwell any longer on matters which are entirely personal and not of interest to others, and must apologise for having so far trespassed upon your valuable space.

C. P. Elieson.

Mr. Radcliffe Ward has, in my opinion, lost a good opportunity of leaving in ignorance those who were not already aware that he was the gentleman entrusted to carry out the first experiment of electric traction at Leytonstone. I am, however, grateful for his corrections, but they do not materially alter the facts.

C. P. Elieson.

A Further Explanation.

We thank you for a review in your valuable paper of our pamphlet on "Electric Lighting, its present position and future prospects," and with reference to the apparent contradiction contained in the clause respecting the Electric Lighting Act, 1882, we see that we might have expressed our views more clearly. The following information, however, will, we trust, be sufficient to explain our meaning. The older forms of parallel lighting carried out on a low tension system necessitated underground wires, owing to their great bulk and weight, and persons wishing to start immediate operations could therefore only do so by working under the Electric Lighting Act, 1882. By means of the converter system, however, overhead wires could be successfully used and any person could immediately start operations as an ordinary private concern, there being no necessity, by the use of overhead wires, to work under the Electric Lighting Act. When their business was thoroughly established they could either make an application for a Provisional Order under the Act of 1882, or wait until the amendments suggested by Lord Thurlow's Bill were agreed to by Parliament. The supply of electricity could then be made by underground mains which, we feel sure you will agree with us, is the only satisfactory and permanent method of supplying electricity for house to house electric lighting.

Hammond & Co.

August 1st, 1888.

High Potential Dynamos.

In my last letter 10 volts per bar should, of course, read 20 volts. The mean E.M.F. per bar mentioned by Mr. Esson seems rather high, especially when it is considered that the maximum E.M.F. between some of the bars must be about 36 volts. As Mr. Esson says, the E.M.F. on the commutator is only one of the many points to be considered when designing a high potential dynamo, and I am sorry he did not notice another important point raised in my letter, viz., whether arc lighting machines should be shunt or series wound.

Judging from your note in last week's issue, a better time is coming in the efficiency of arc lighters. No doubt Messrs. Shippey will give us some reliable electrical data, but at present the new arrival from the other side looks as if it was going to "lick creation."

William H. Faves.

Coventry, *August 6th*, 1888.